Simulation Statistics

By Sagar and Siddhant
Under the guidance of Dr. Ankhi Roy

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IIT Indore

Contents

Histograms for energy resolution of detectors by applying manual clustering and incorporating slice-wise recalibration, for the following detector-particle pairs:

- Electron: CEMC, EEMC, FEMC
- Pion: FEMC + FHCAL, CEMC + HCALIN + HCALOUT

tphi : tower ϕ, ttheta : tower θ, te_{agg}: tower energies aggregated in an event
gphi : generated ϕ, gtheta : generated θ, ge: generated energy

Simulation Parameters

- Particles: e^- , pi^-
- Events: 100,000 per particle
- momentum (p): 0 to 30 GeV/c
- Pseudorapidity (η): -4 to 4
- Azimuth (Φ): -π to π

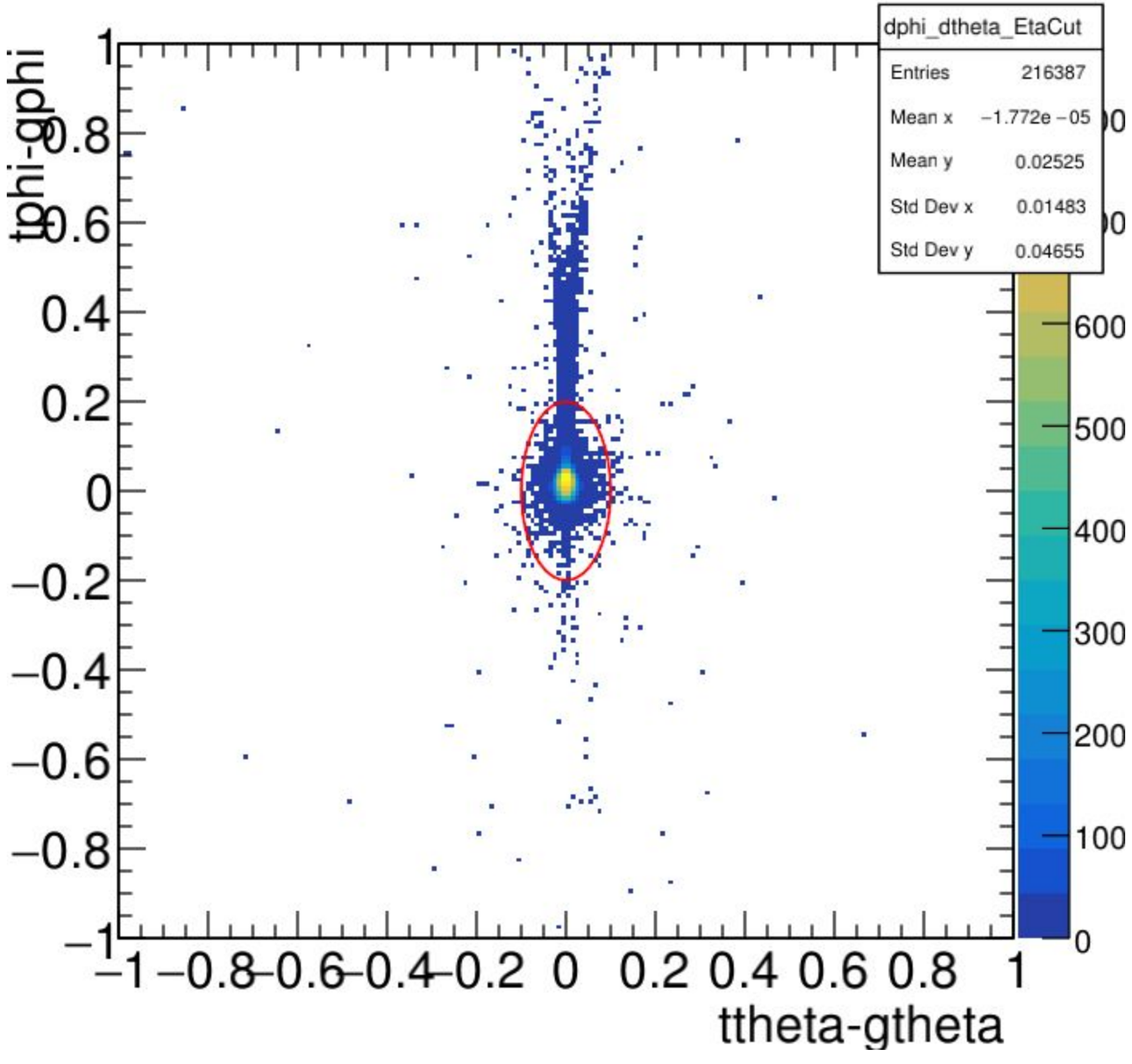
Cuts:

- Detector-wise η cuts (intersection of η ranges in case of detector combinations)
- Detector-wise Elliptical cuts in dphi vs dtheta plots (simultaneously included in case of detector combinations)
- Energy cut on Towers (200 MeV)

CEMC (e^-)

CEMC (e^-)

Elliptical cut on dphi vs dtheta, Explicit η cut: -1.5 to 1.2, 200 MeV Energy Cut



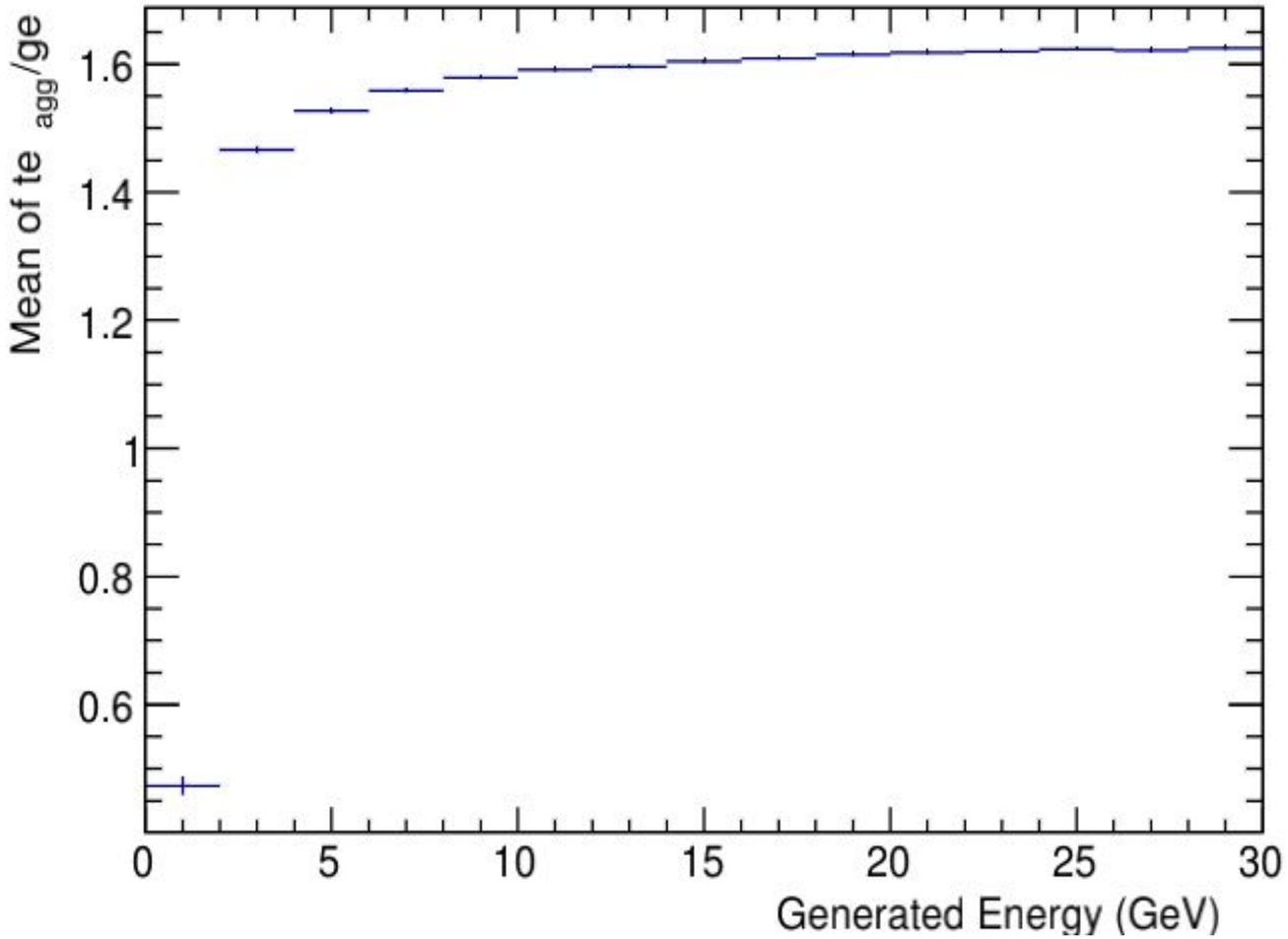
Elliptical Cut: Only the towers within the elliptical region (centered at origin) are considered for further analysis.

Dimensions:

semi-minor axis = 0.10 units
semi-major axis = 0.20 units

CEMC (e^-)

Elliptical cut on dphi vs dtheta
Explicit η cut: -1.5 to 1.2
200 MeV Energy Cut



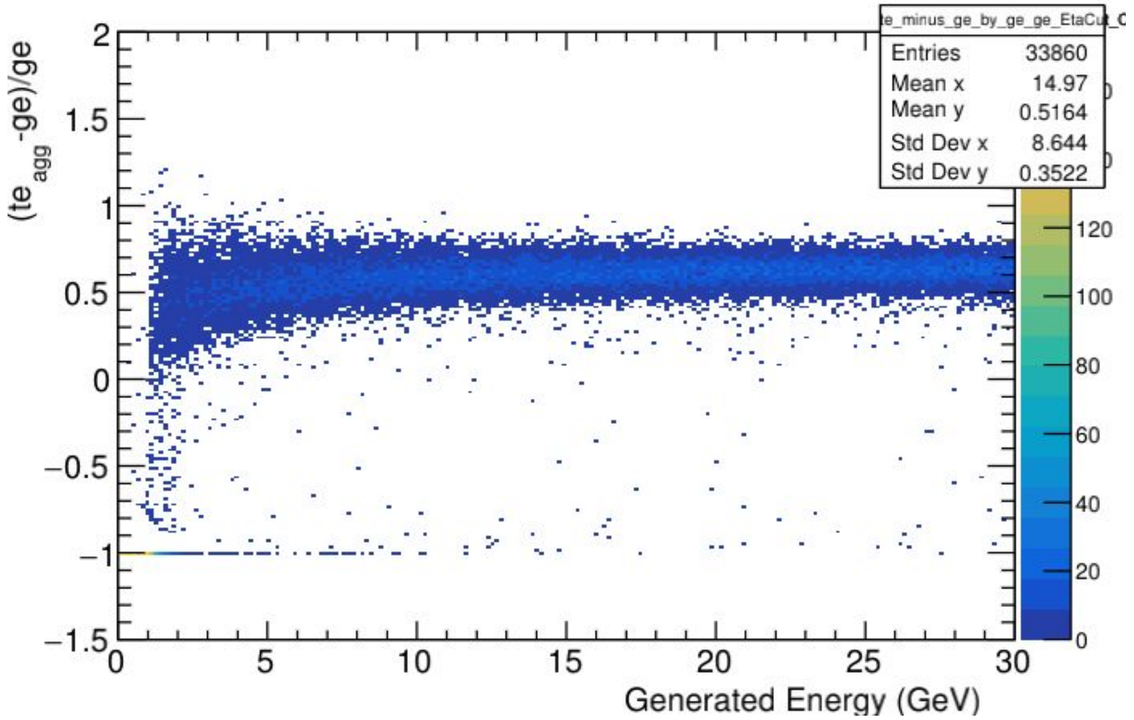
Each slice of `(te`$_{agg}$`-ge)/ge vs ge` plot will be recalibrated on the basis of dividing by a recalibration factor which equals to the Mean of `te`$_{agg}$`/ge` corresponding to that particular slice in this plot.

*The Recalibration factor for the first slice has been decided manually because the value from this plot doesn't seem to be optimum, owing to a relative surplus of low energy entries close to 200 MeV.

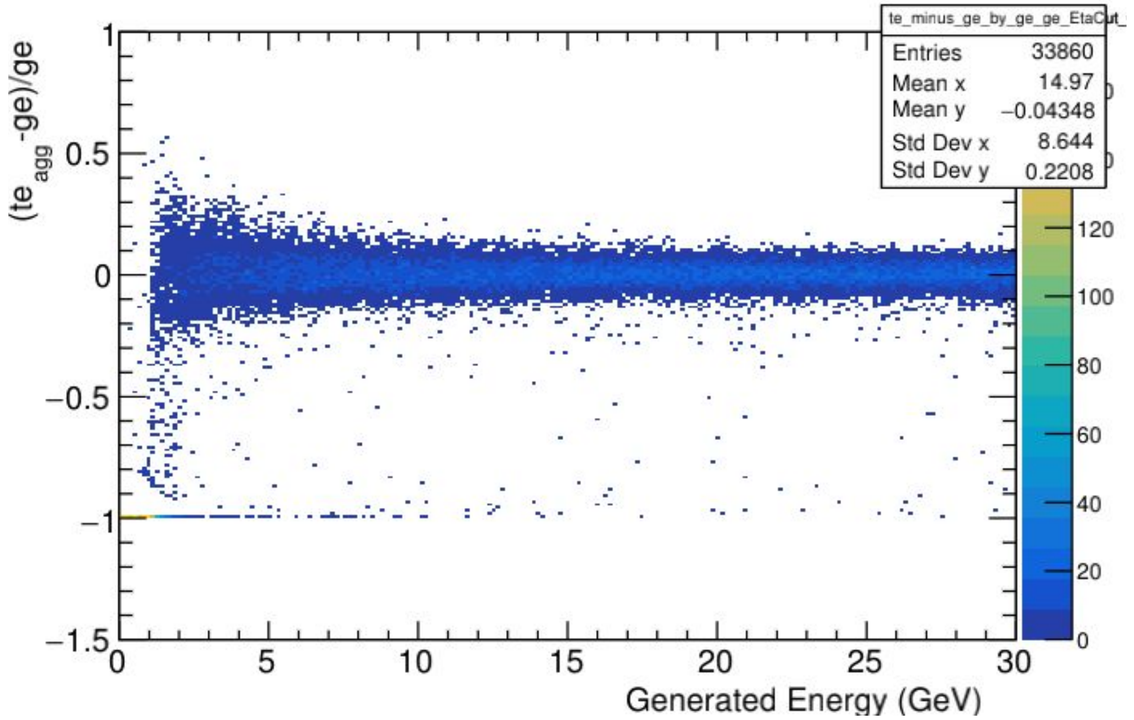
recalibrationFactor of first slice = 1.414

CEMC (e^-)

(te_{agg}-ge)/ge vs ge
Explicit η cut: -1.5 to 1.2
200 MeV Energy Cut

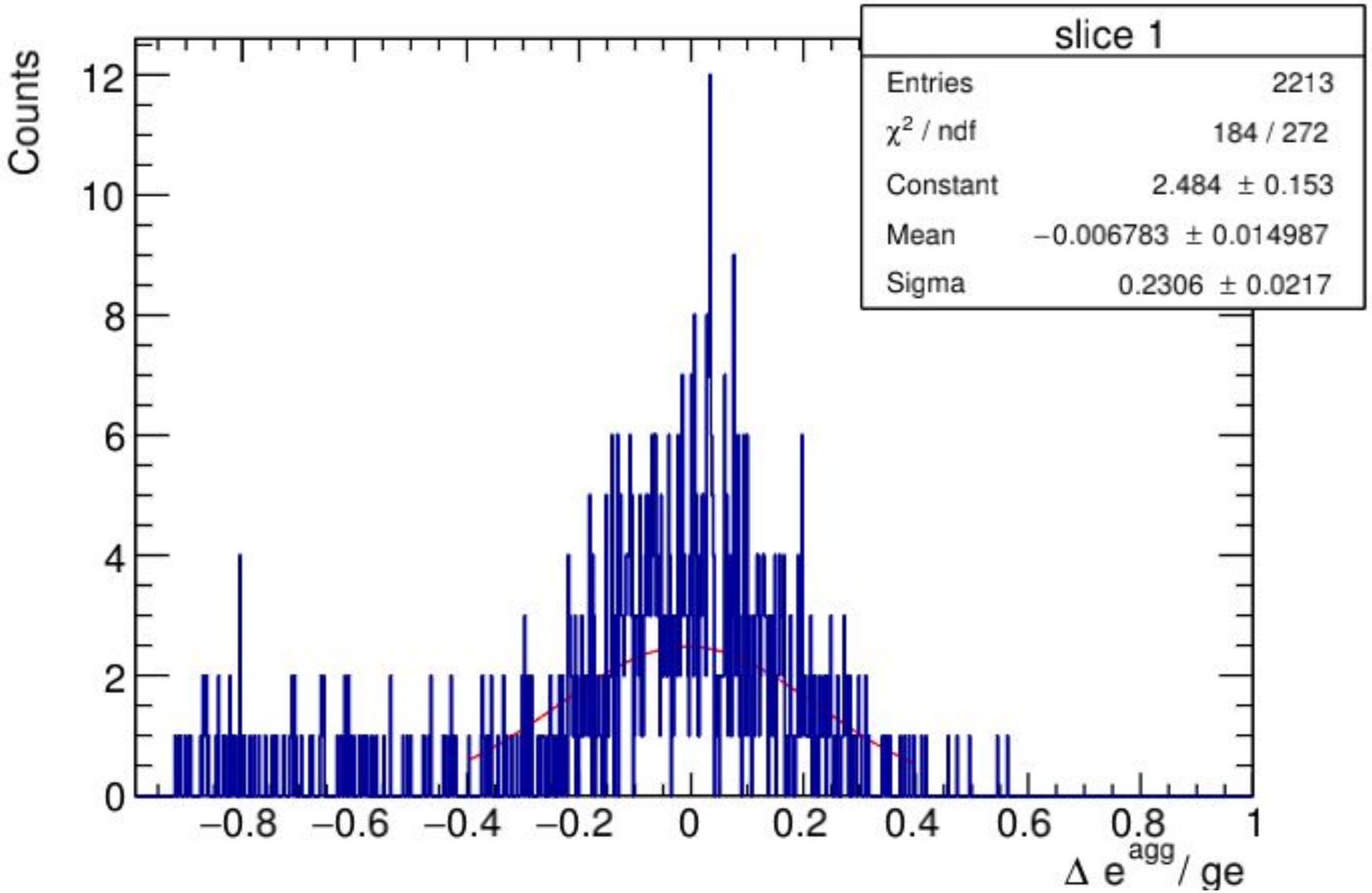


After Recalibration (te → te/recalibrationFactor)



CEMC (e^-)

(te_{agg}-ge)/ge vs ge
Gaussian fit of the first slice (0-2 GeV)



This is the gaussian fit of the first slice of the recalibrated `(te_agg-ge)/ge vs ge` plot.
(shown on the previous slide)

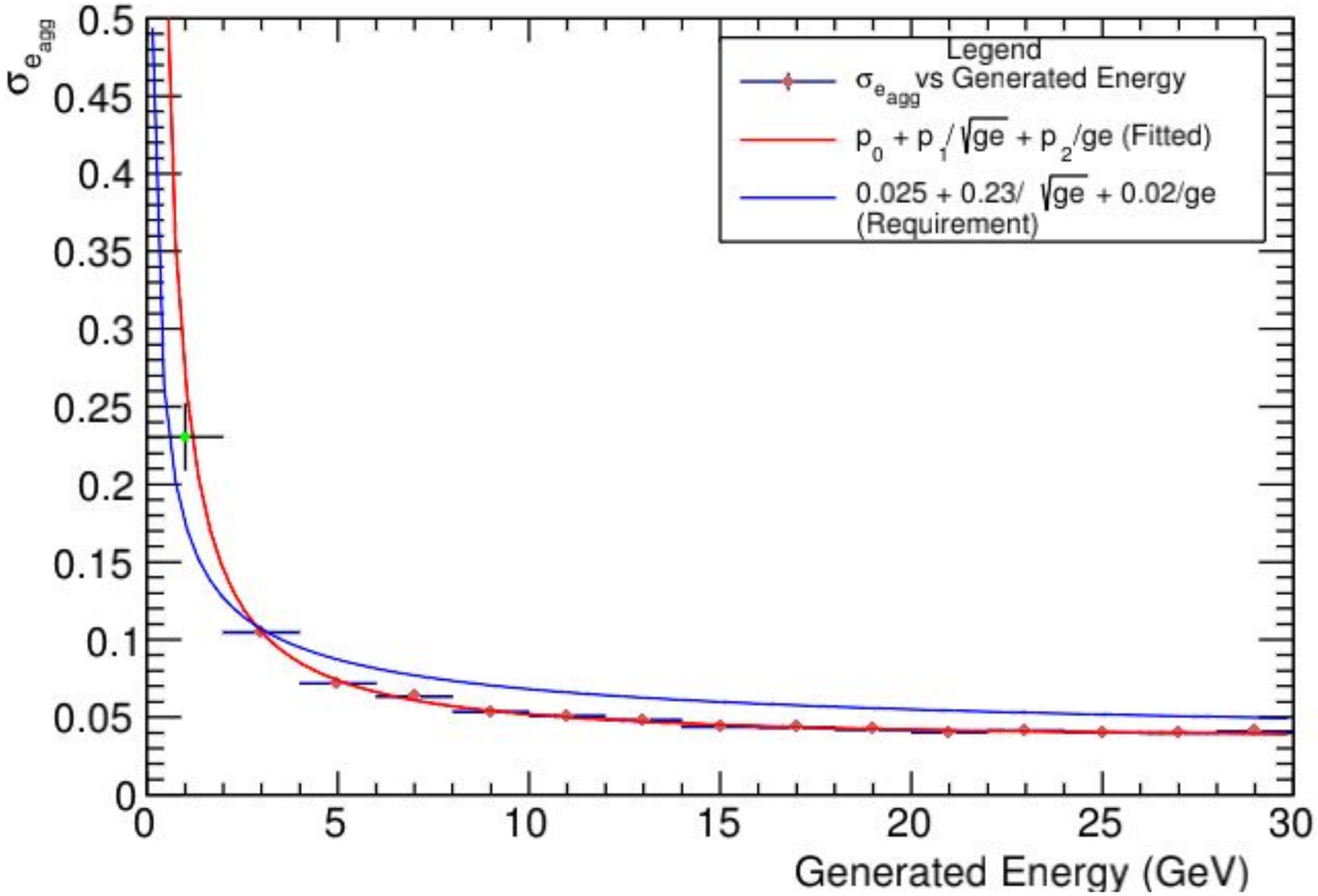
This fit has been done manually by restricting the fit range of the gaussian from -0.40 to 0.40

*All other gaussians have been fit over the entire range.

Number of bins = 1000 from -0.99 to +1.0

CEMC (e^-)

σ_e_{agg} vs ge
Explicit η cut: -1.5 to 1.2
Elliptical Cut
200 MeV Energy Cut



`σe` refers to the standard deviation of the Gaussian fitted to a slice of the recalibrated `(te`$_{agg}$`-ge)/ge vs ge` plot.
(shown on slide 7)

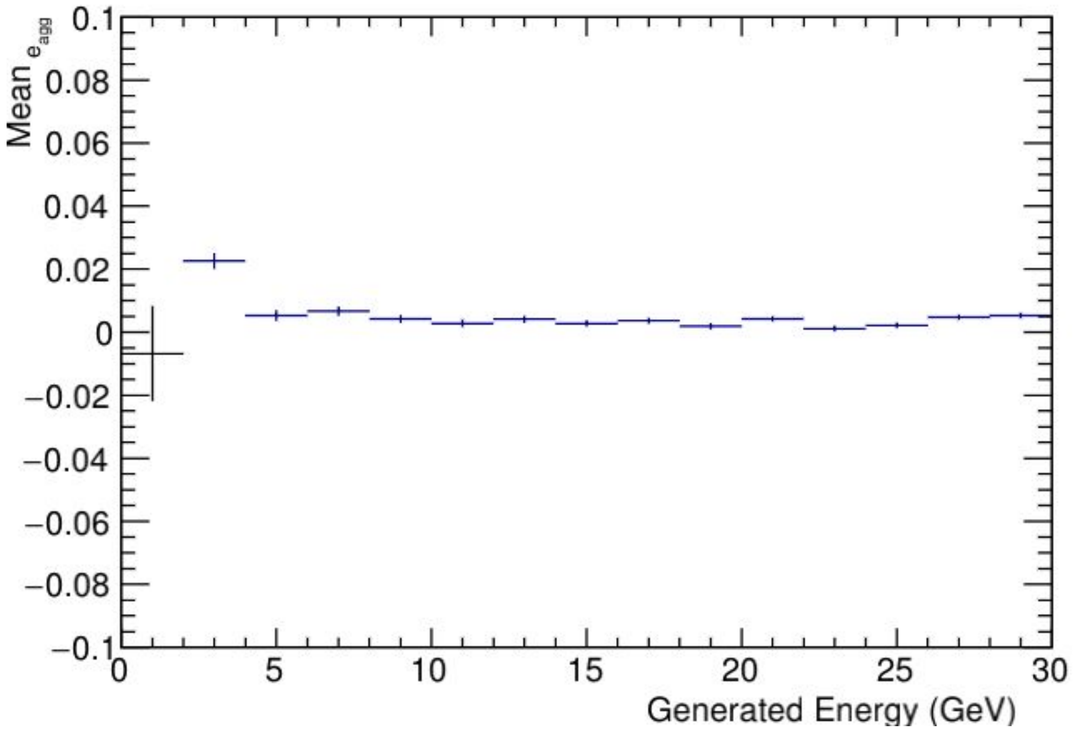
Number of bins = 15
Bin Width = 2 GeV

Fit Parameters:
p_o = (0.0379450 +- 0.00271833)
p_1 = (-0.0431198 +- 0.0183320) $GeV^{0.5}$
p_2 = (0.275279 +- 0.0286286) GeV

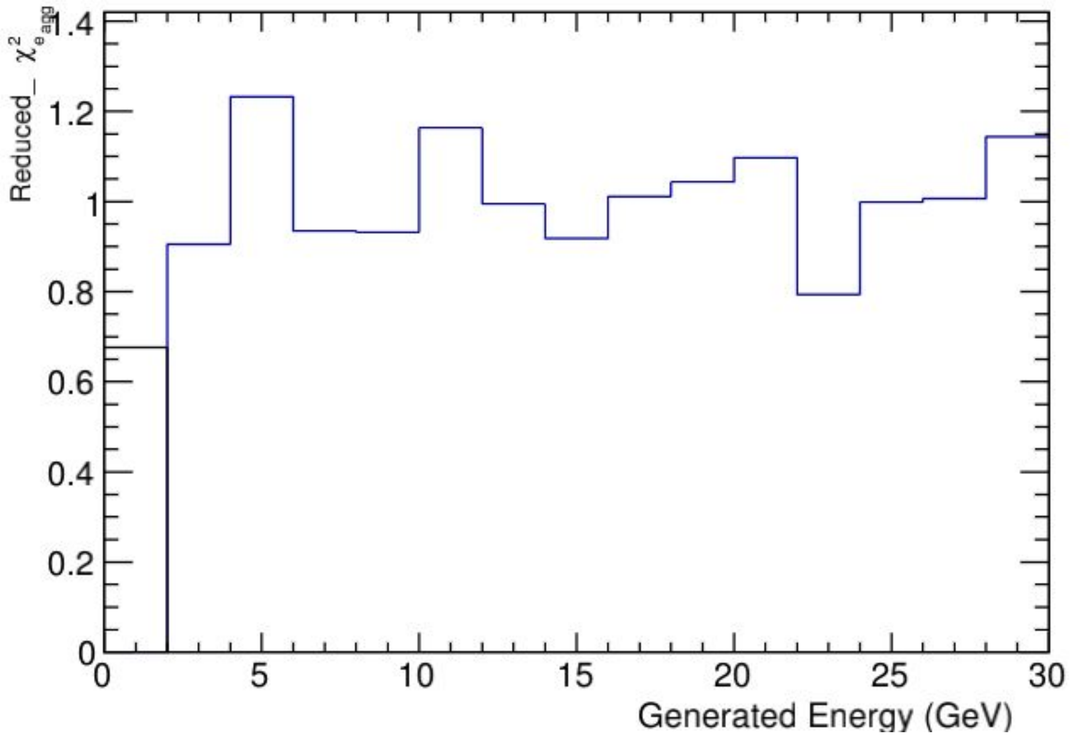
The fit does not account for the first slice. The first slice was overlaid manually over the plot.

CEMC (e^-)

Explicit η cut: -1.5 to 1.2
Elliptical cut, 200 MeV Energy cut



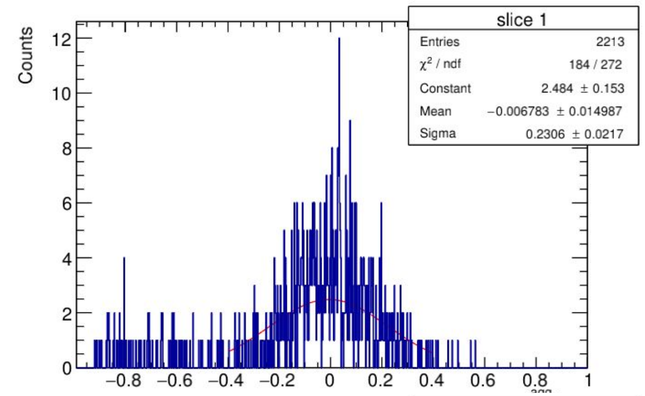
Mean of the Gaussians fitted to the slices of the recalibrated `(te`$_{agg}$`-ge)/ge vs ge` plot.

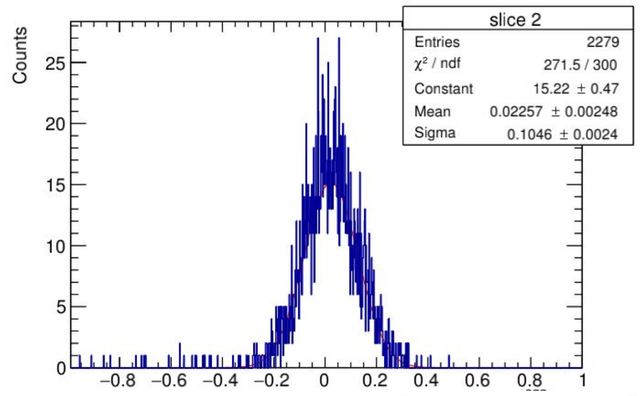


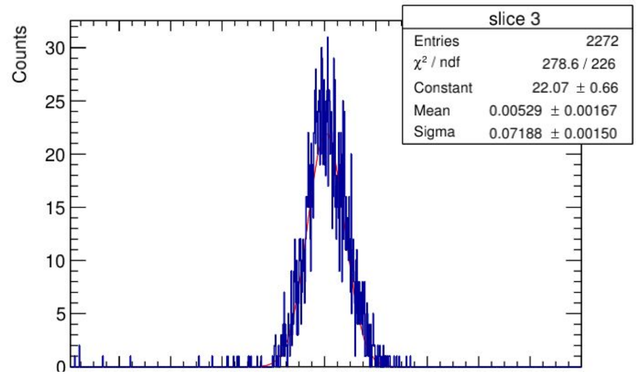
Reduced_χ2 of the Gaussians fitted to the slices of the recalibrated `(te`$_{agg}$`-ge)/ge vs ge` plot.

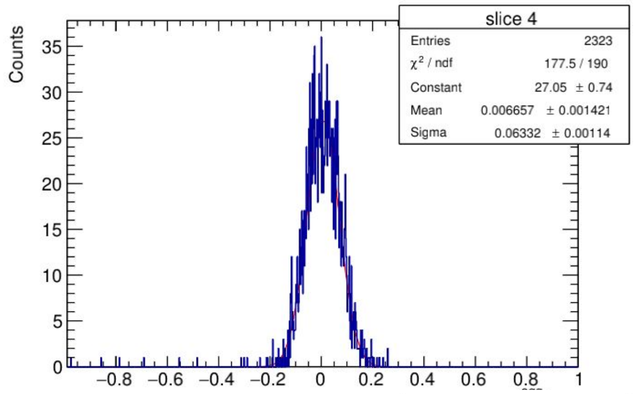
CEMC (e^-)

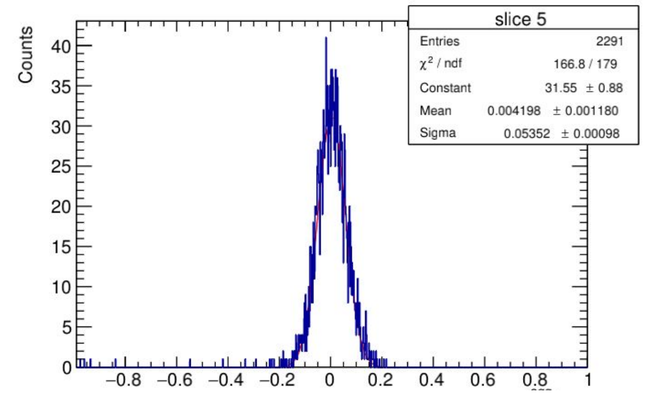
Fitted Gaussians

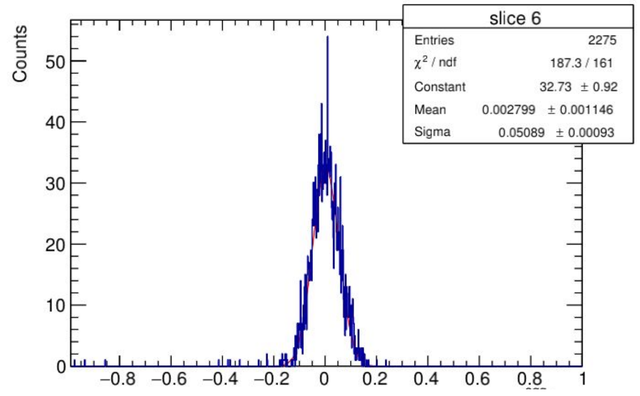


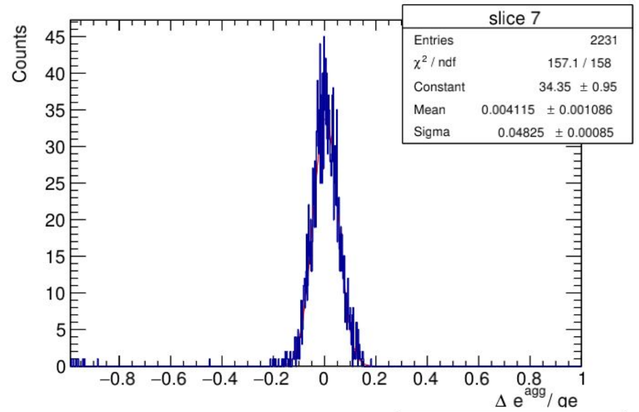


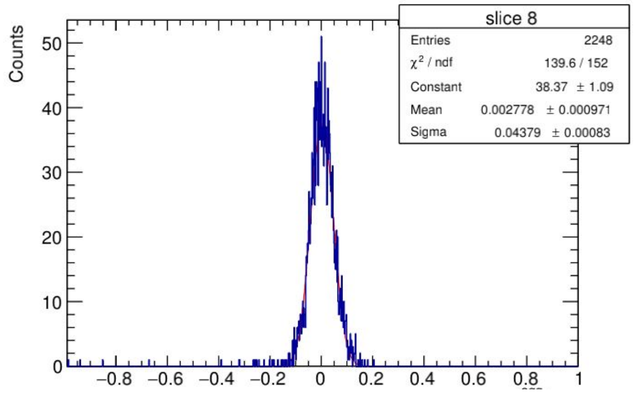


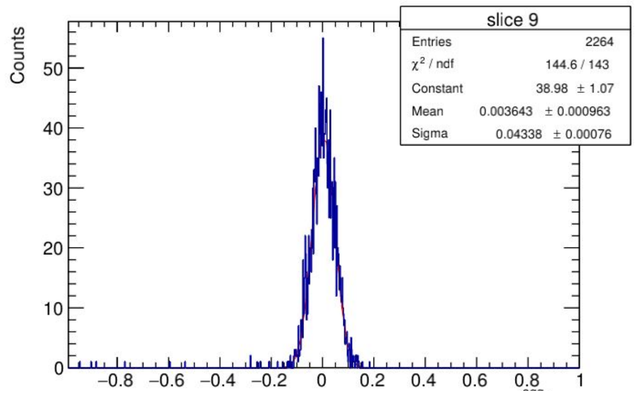


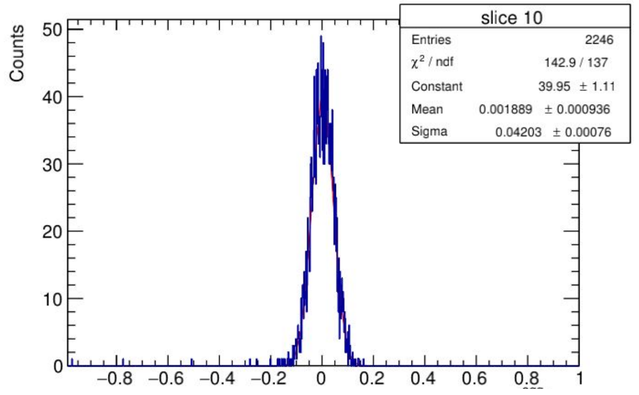


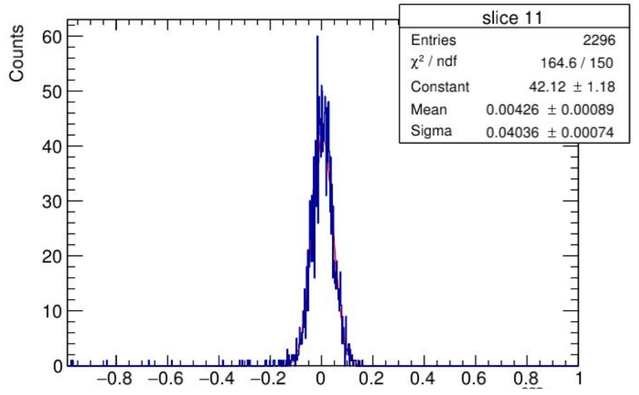


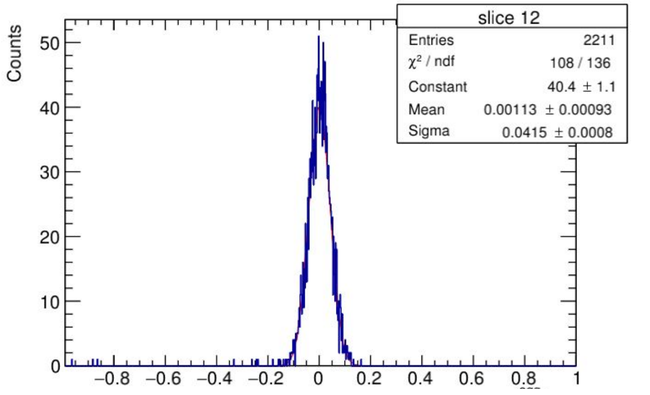








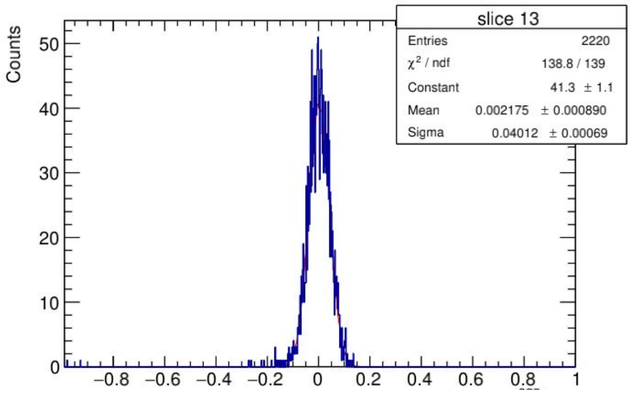


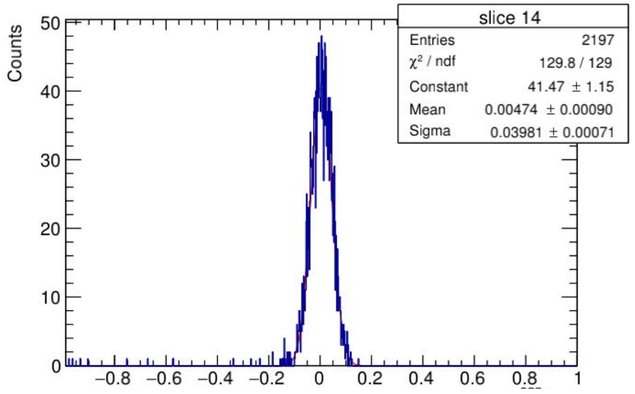


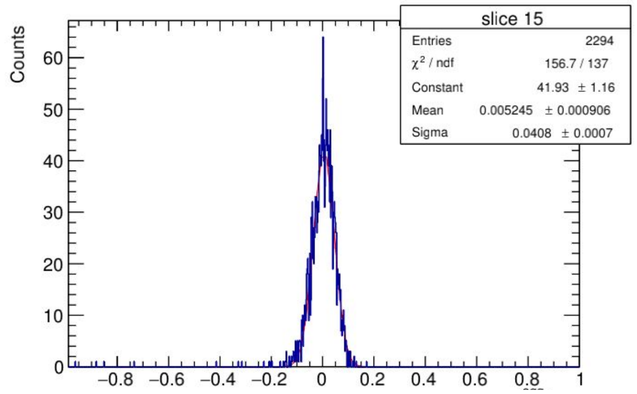
The x-axes denote $\Delta e_{agg}/ge$

CEMC (e^-)

Fitted Gaussians





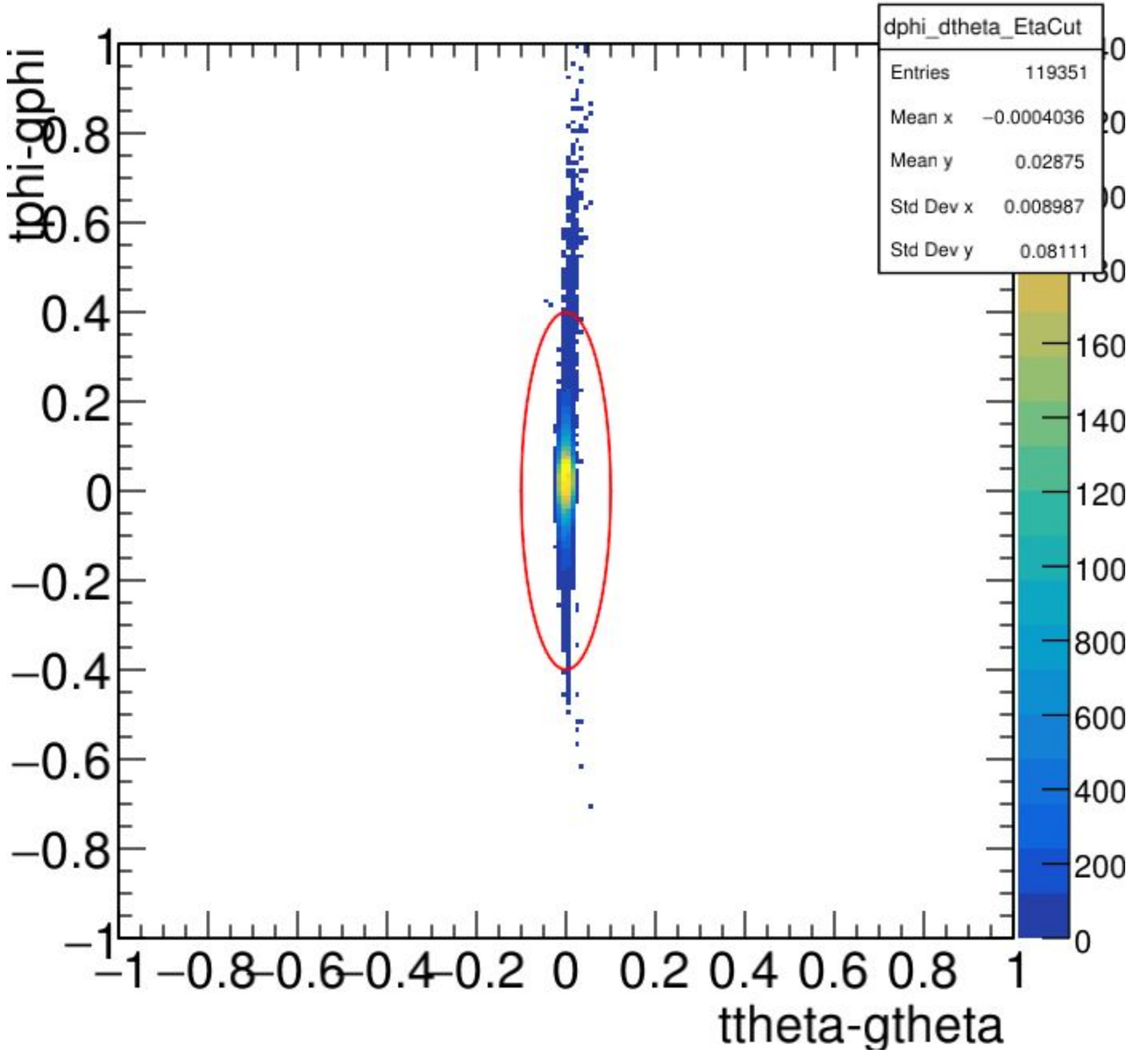


The x-axes denote $\Delta e_{agg}/ge$

EEMC (e^-)

EEMC (e^-)

Elliptical cut on dphi vs dtheta, Explicit η cut: -3.5 to -1.7



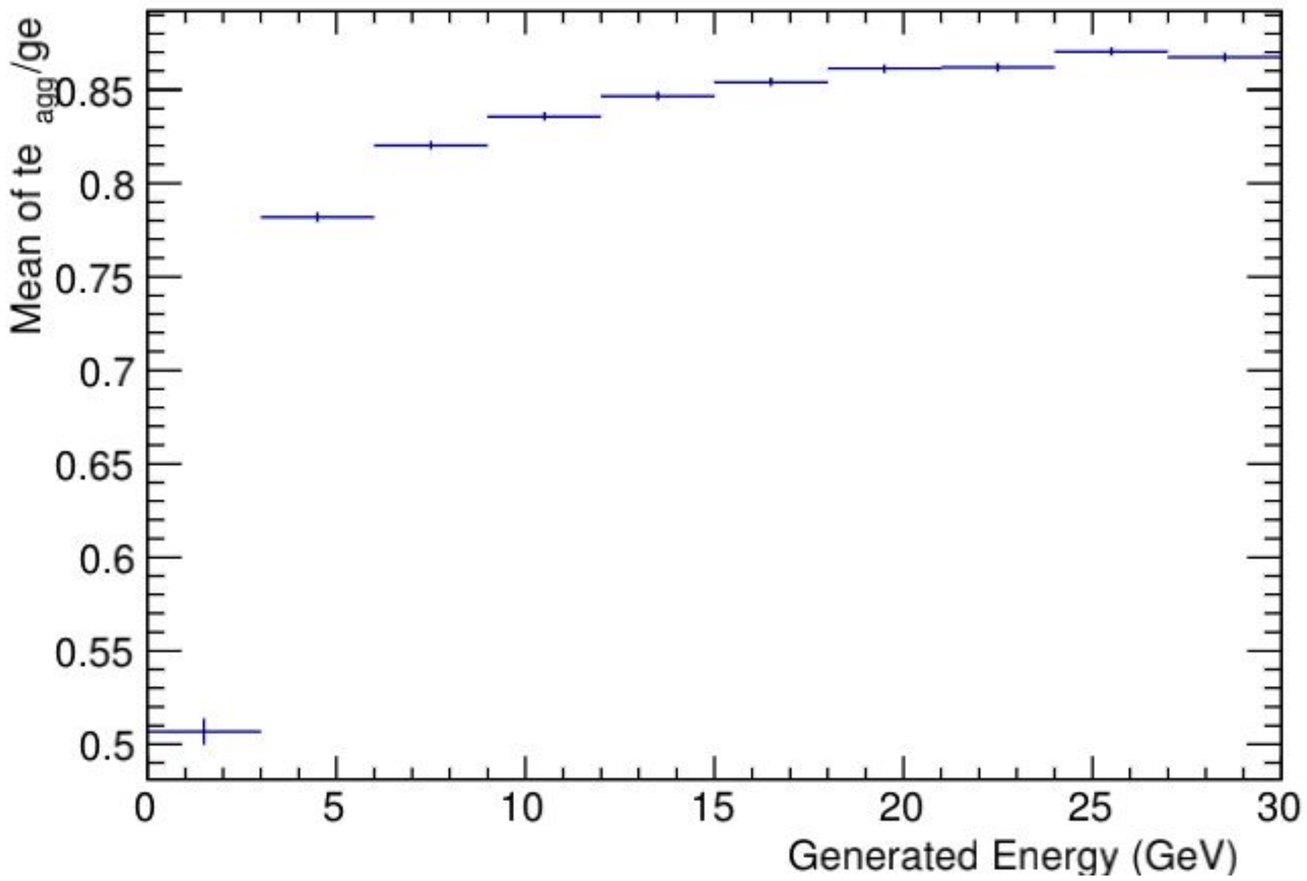
Elliptical Cut: Only the towers within the elliptical region (centered at origin) are considered for further analysis.

Dimensions:

semi-minor axis = 0.10 units
semi-major axis = 0.40 units

EEMC (e^-)

Elliptical cut on dphi vs dtheta
Explicit η cut: -3.5 to -1.7
200 MeV Energy Cut



(te → te/recalibrationFactor)

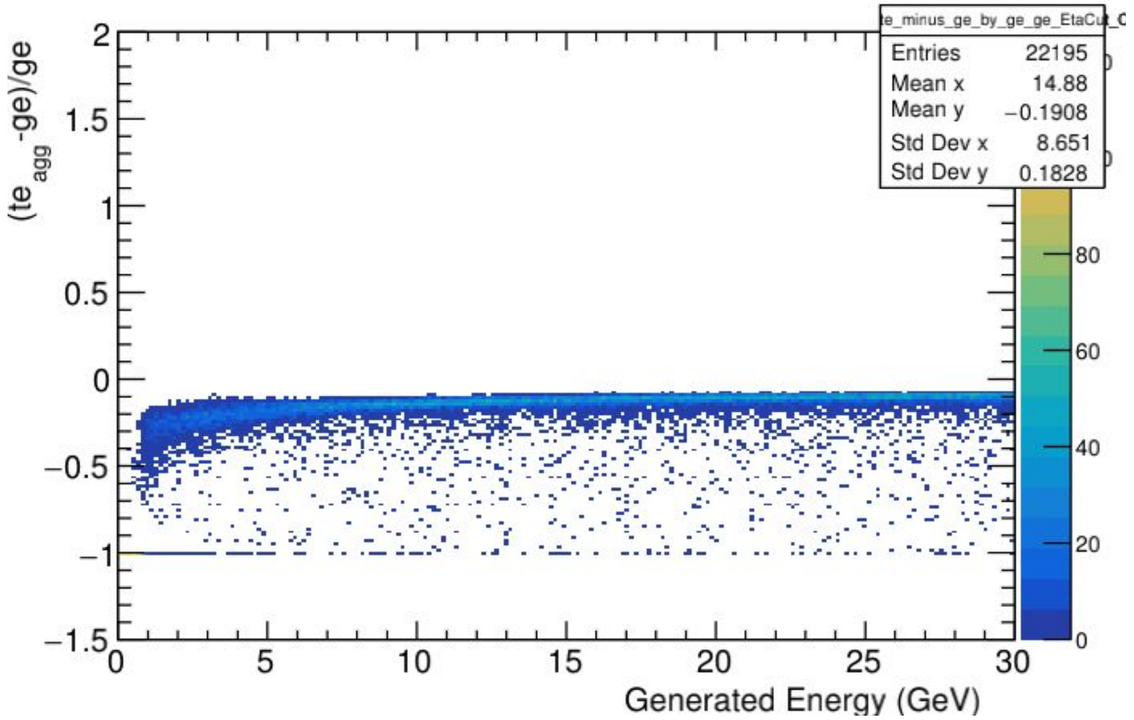
Each slice of `(te`$_{agg}$`-ge)/ge vs ge` plot will be recalibrated on the basis of dividing by a recalibration factor which equals to the Mean of `te`$_{agg}$`/ge` corresponding to that particular slice in this plot.

*The Recalibration factor for the first slice has been decided manually because the value from this plot doesn't seem to be optimum, owing to a relative surplus of low energy entries close to 200 MeV.

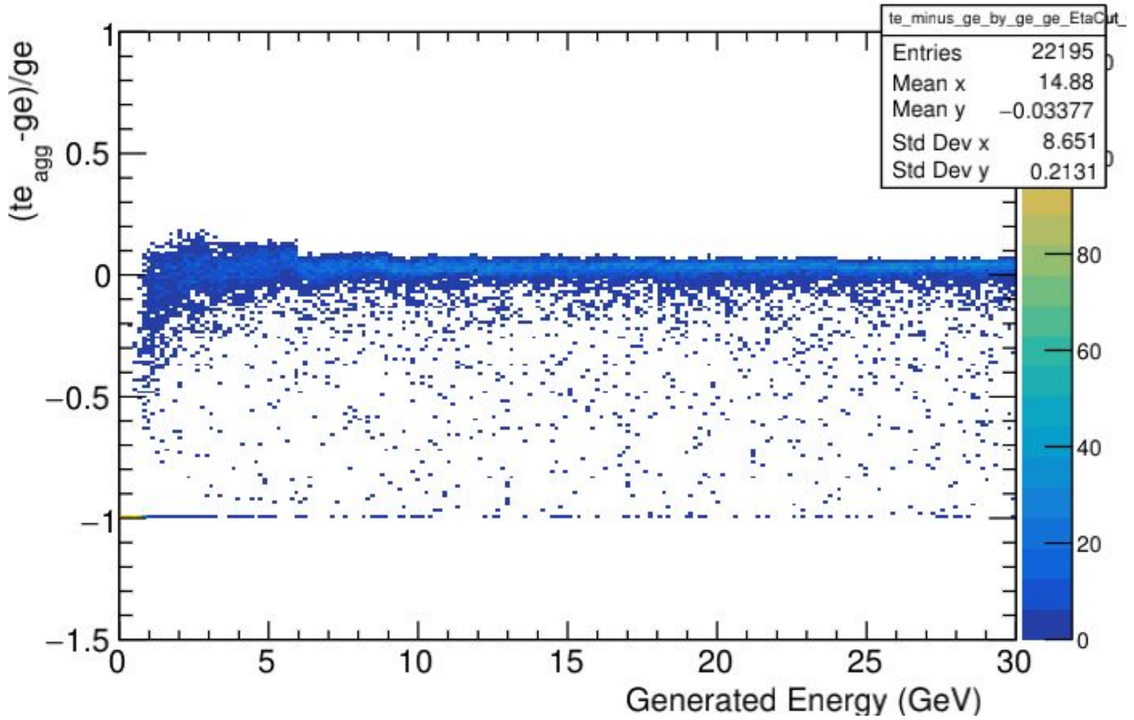
recalibrationFactor of first slice = 0.75

EEMC (e^-)

(te_{agg}-ge)/ge vs ge
Explicit η cut: -3.5 to -1.7
200 MeV energy cut



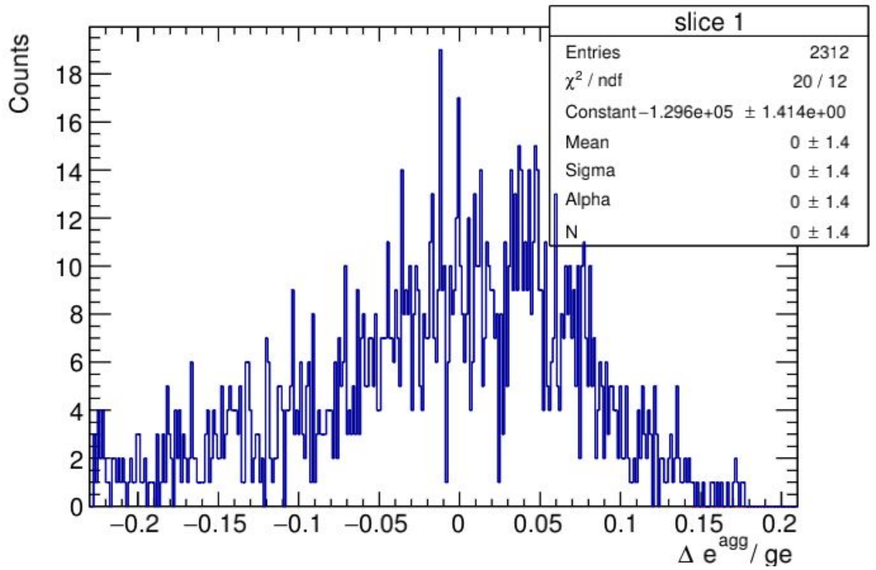
After Recalibration (te → te/recalibrationFactor)

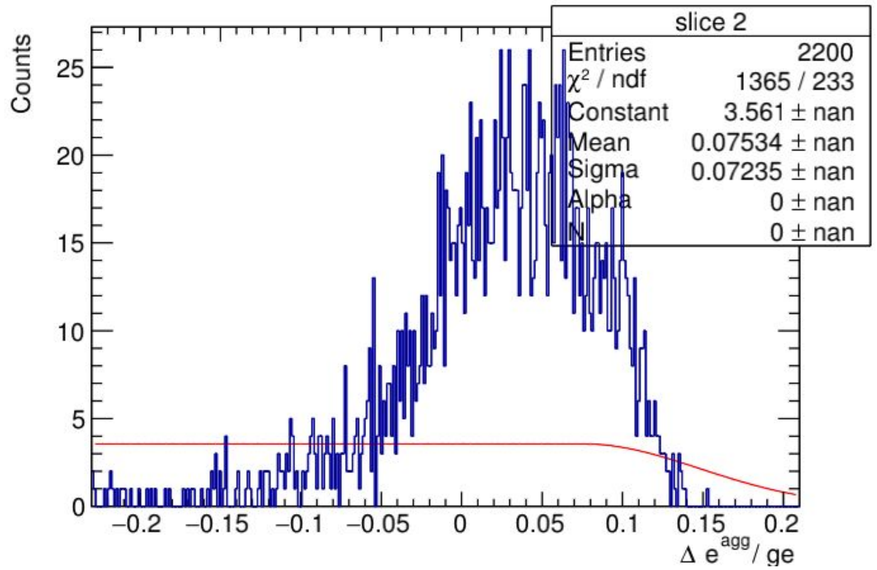


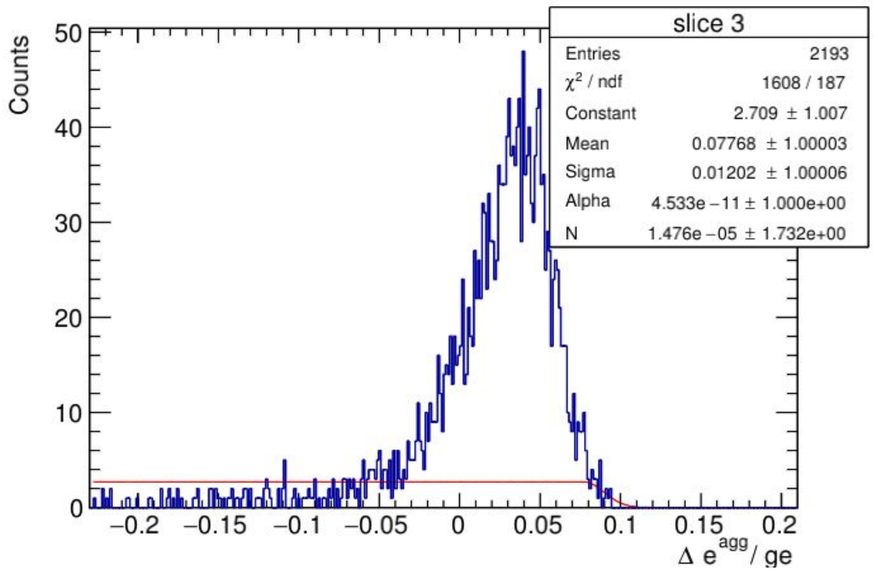
EEMC (e^-)

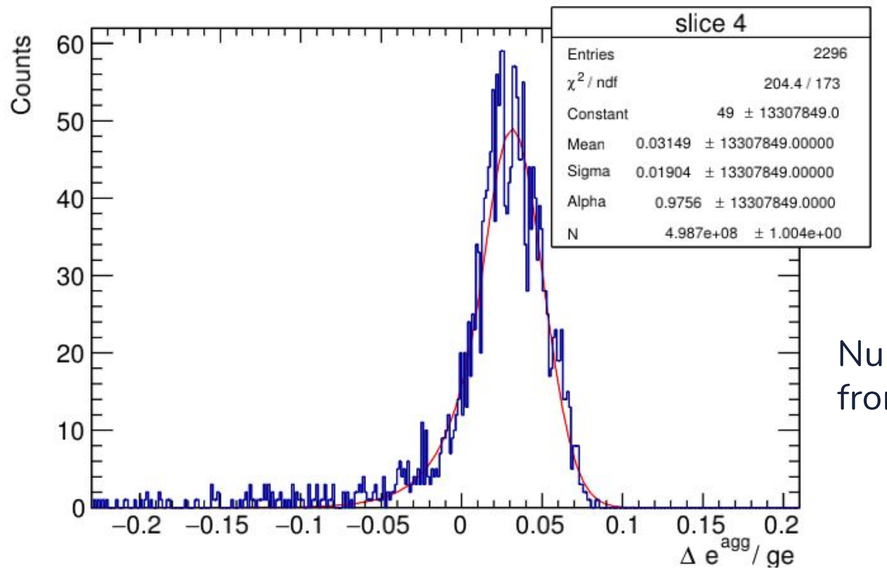
(te_{agg}-ge)/ge vs ge

Crystal Ball Functions fitted to the first 4 slices (0-12 GeV)









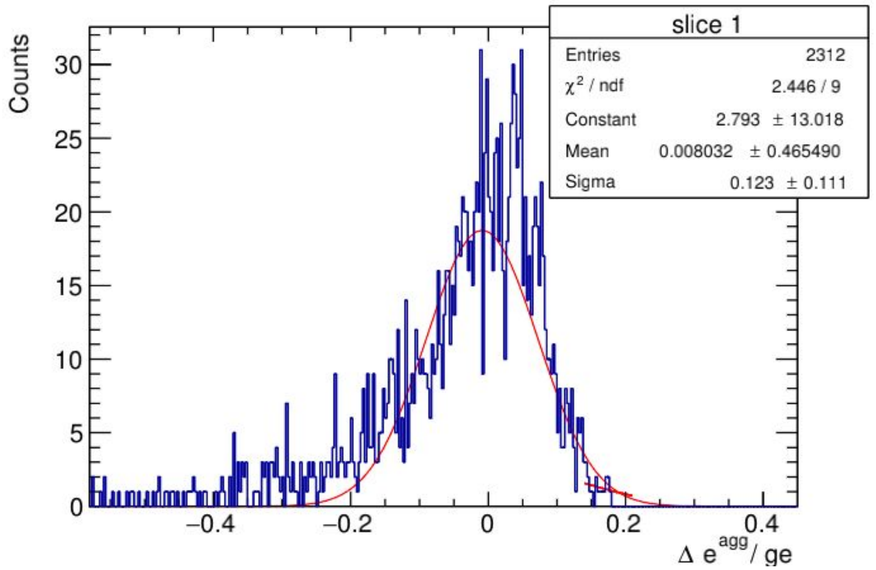
Number of bins = 350
from -0.23 to +0.21

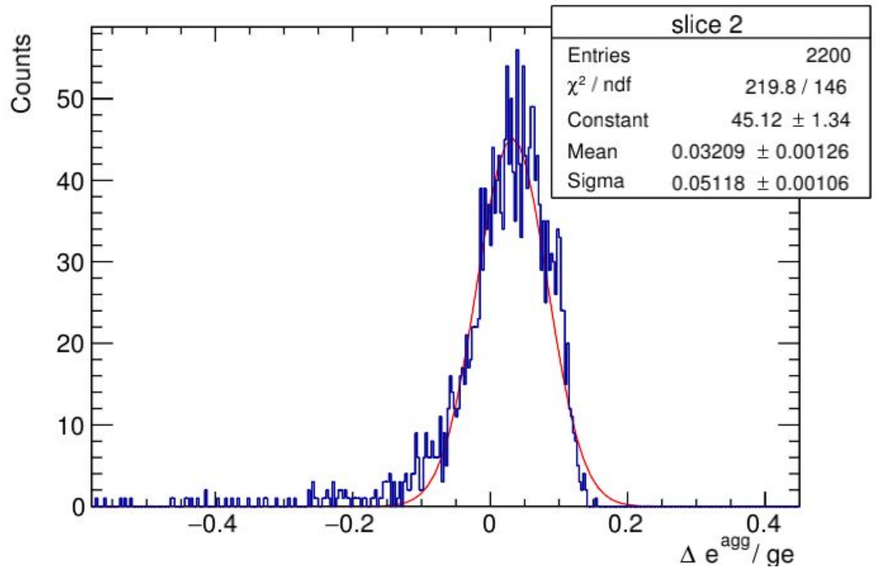
These functions have been fit to the recalibrated `(te_agg-ge)/ge vs ge` plot. (shown on slide 16)

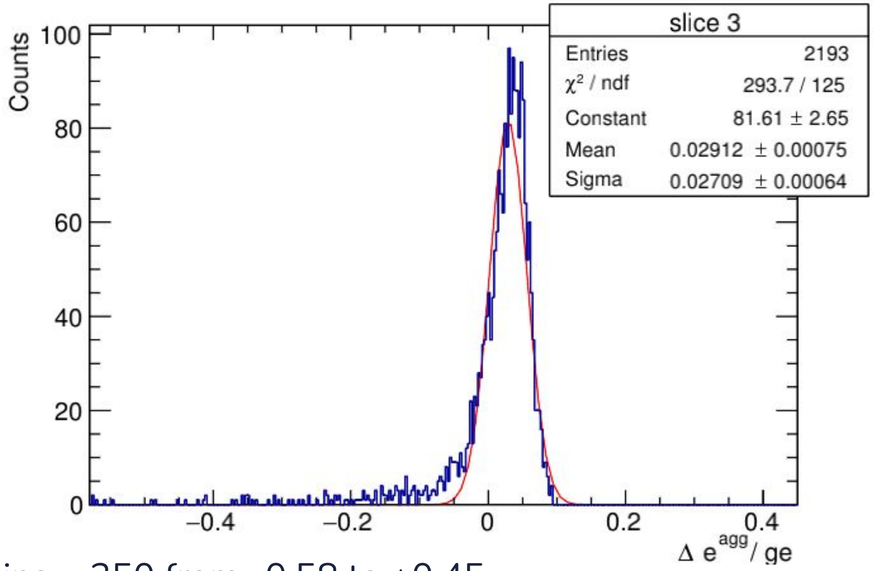
EEMC (e^-)

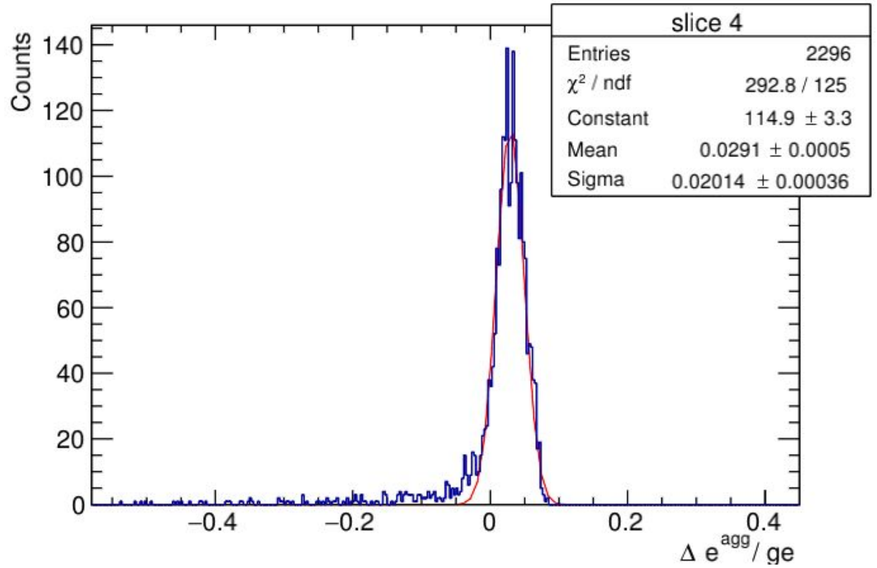
(te_{agg}-ge)/ge vs ge

Gaussians fitted to the first 4 slices (0-12 GeV)







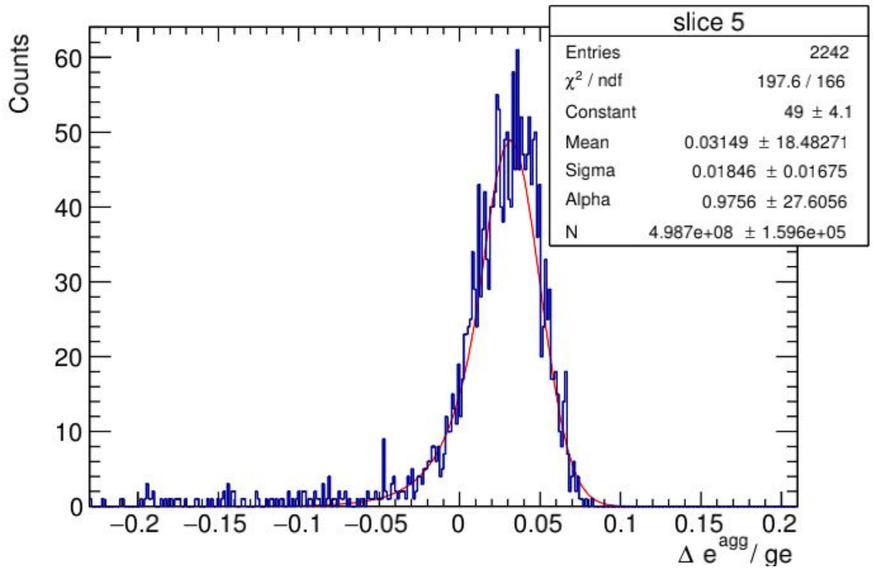


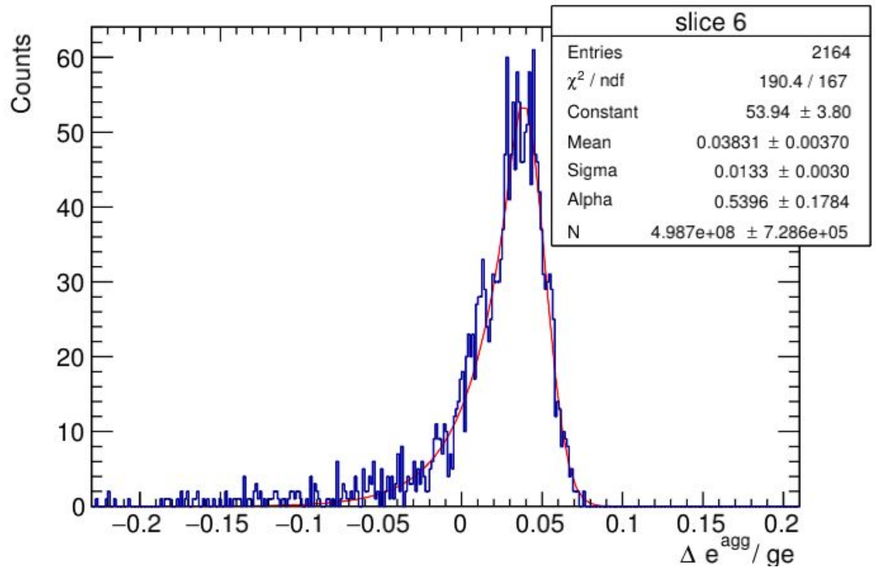
Number of bins = 350 from -0.58 to +0.45

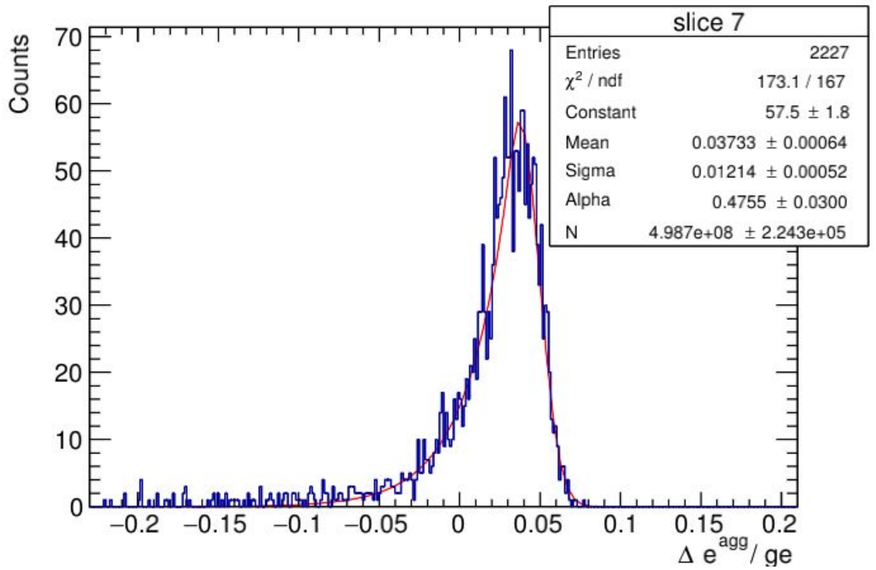
EEMC (e^-)

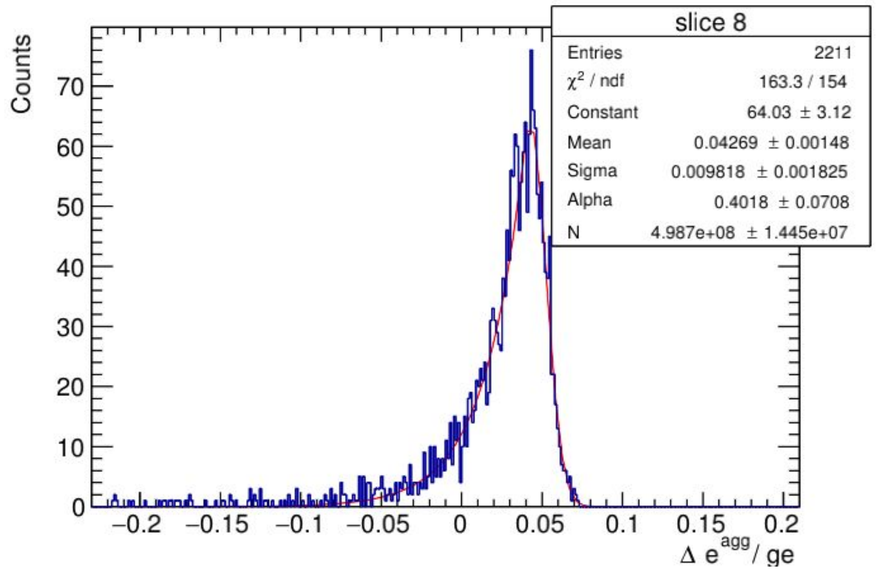
(te_{agg}-ge)/ge vs ge

Crystal Ball Functions fitted to the next 4 slices (12-24 GeV)





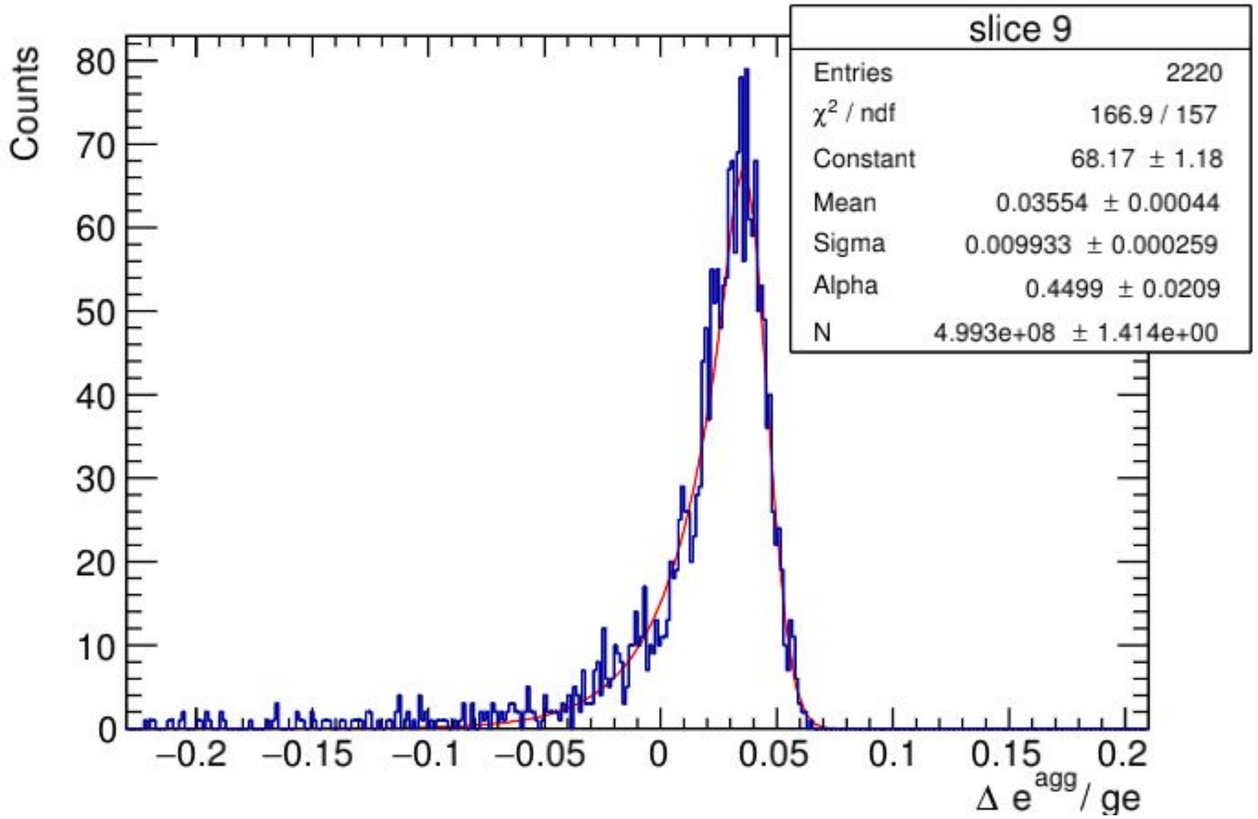


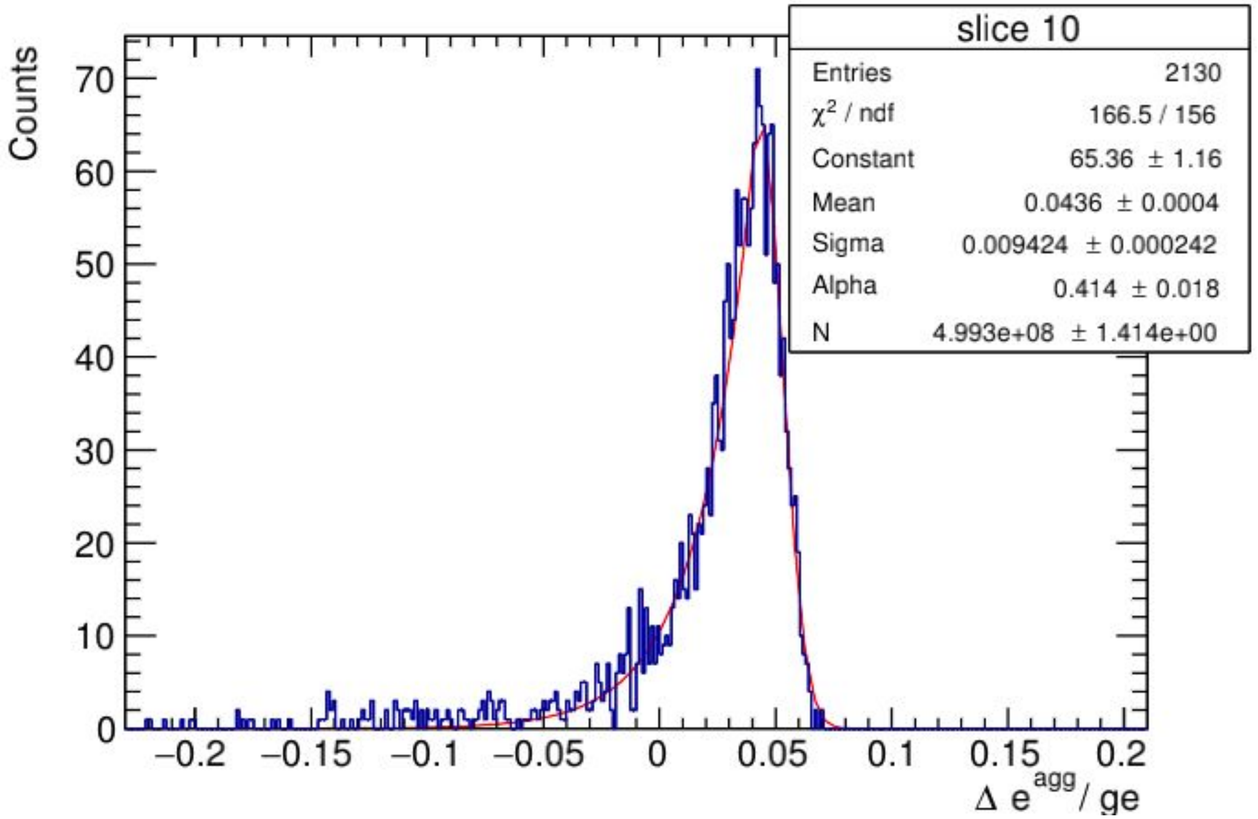


EEMC (e^-)

(te_{agg}-ge)/ge vs ge

Crystal Ball Functions fitted to the last 2 slices (24-30 GeV)

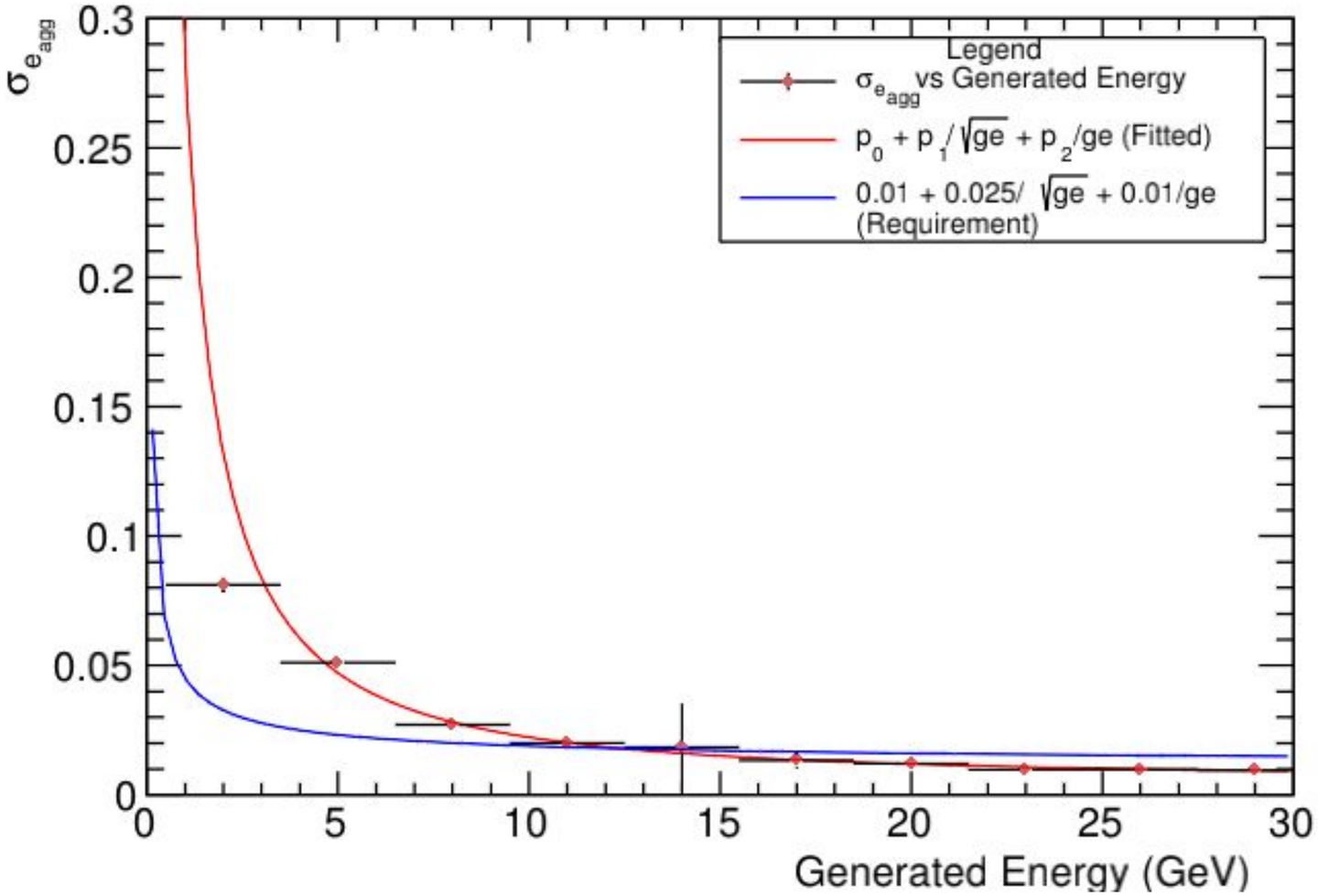




As can be seen from the above plots, the Gaussian function gives a good fit for the initial 4 slices and the Crystal Ball function gives a good fit for the rest of the slices. Hence, further analysis has been done using the most appropriate function for the respective slice.

EEMC (e^-)

σ_e_{agg} vs ge
Explicit η cut: -3.5 to -1.7
Elliptical cut
200 MeV Energy Cut



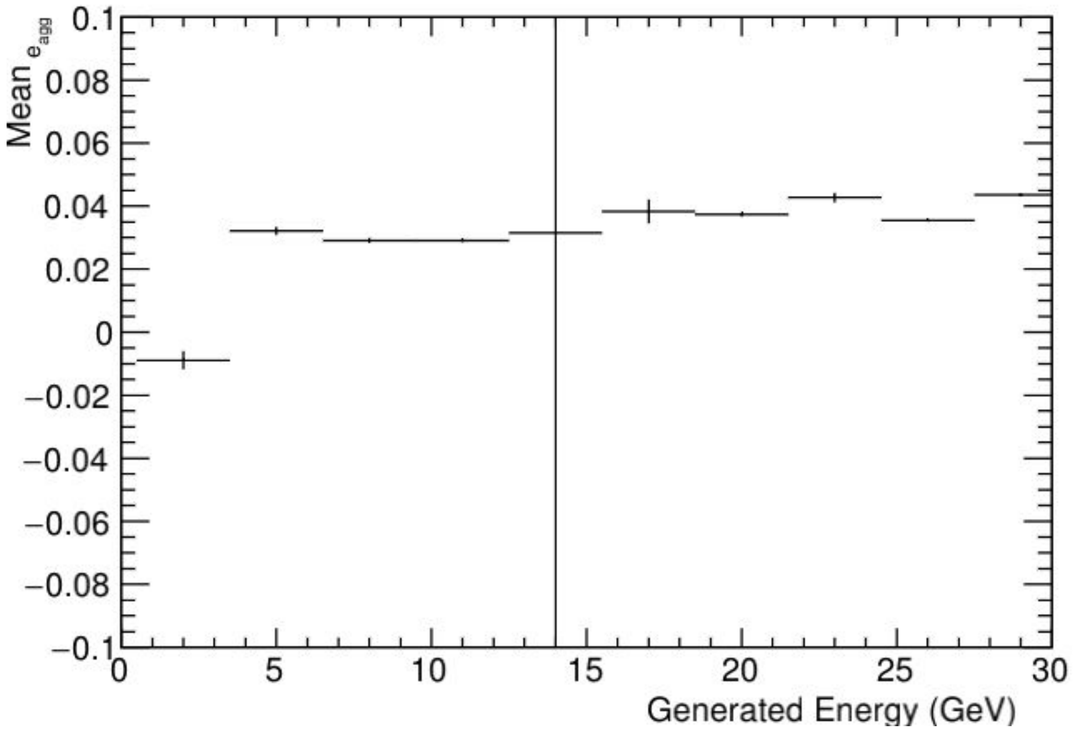
`σe` refers to the standard deviation of the Gaussian fitted to a slice of the recalibrated `(te`$_{agg}$`-ge)/ge vs ge` plot.
(shown on the previous slide)

Number of bins = 10
Bin Width = 3 GeV

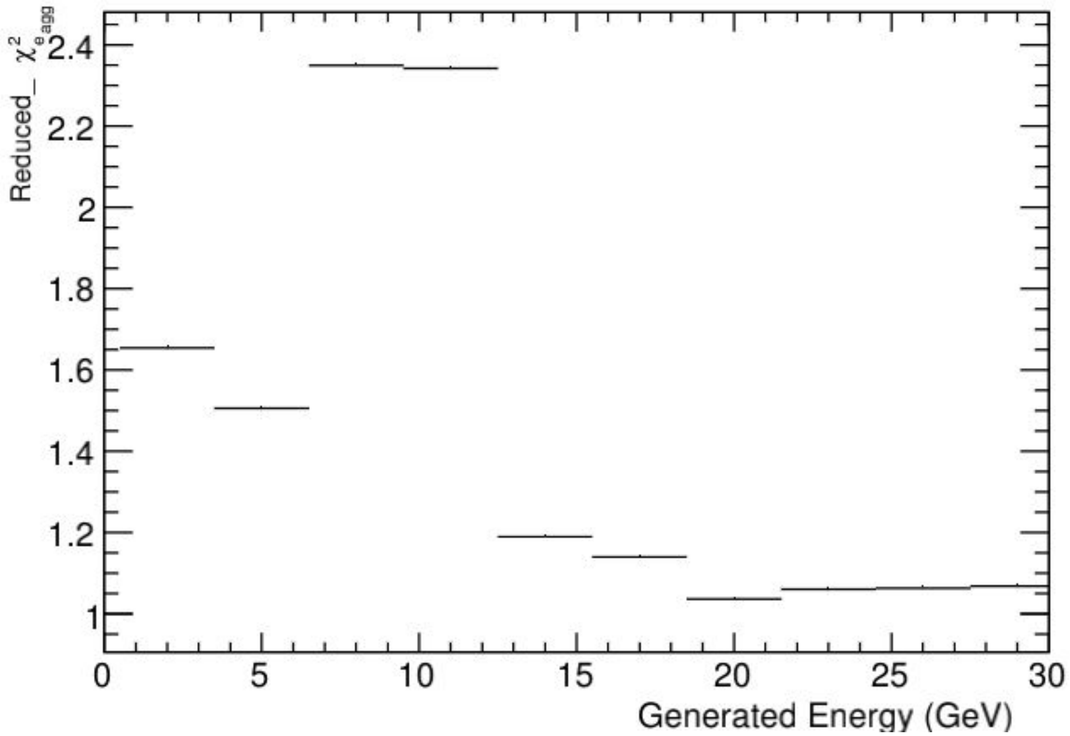
Fit Parameters:
p_o = (0.0114667 +- 0.0112913)
p_1 = (-0.0756919 +- 0.0971071) $GeV^{0.5}$
p_2 = (0.347401 +- 0.203472) GeV

EEMC (e^-)

Explicit η cut: -3.5 to -1.7
Elliptical cut, 200 MeV Energy cut



Mean of the Gaussians fitted to the slices of the recalibrated `(te`$_{agg}$`-ge)/ge vs ge` plot.

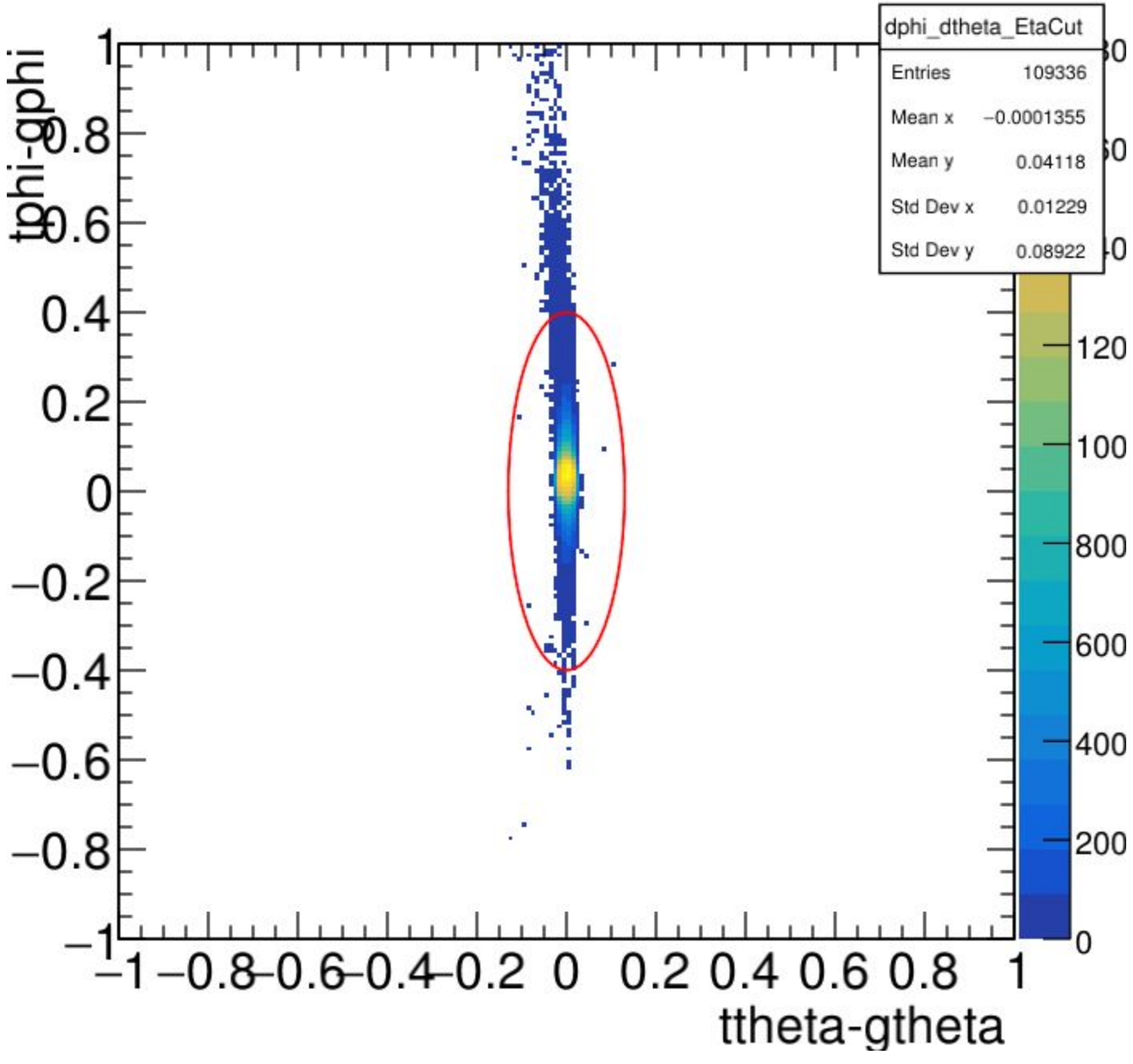


Reduced_χ2 of the Gaussians fitted to the slices of the recalibrated `(te`$_{agg}$`-ge)/ge vs ge` plot.

FEMC (e^-)

FEMC (e^-)

Elliptical cut on dphi vs dtheta, Explicit η cut: 1.3 to 3.3, 200 MeV Energy



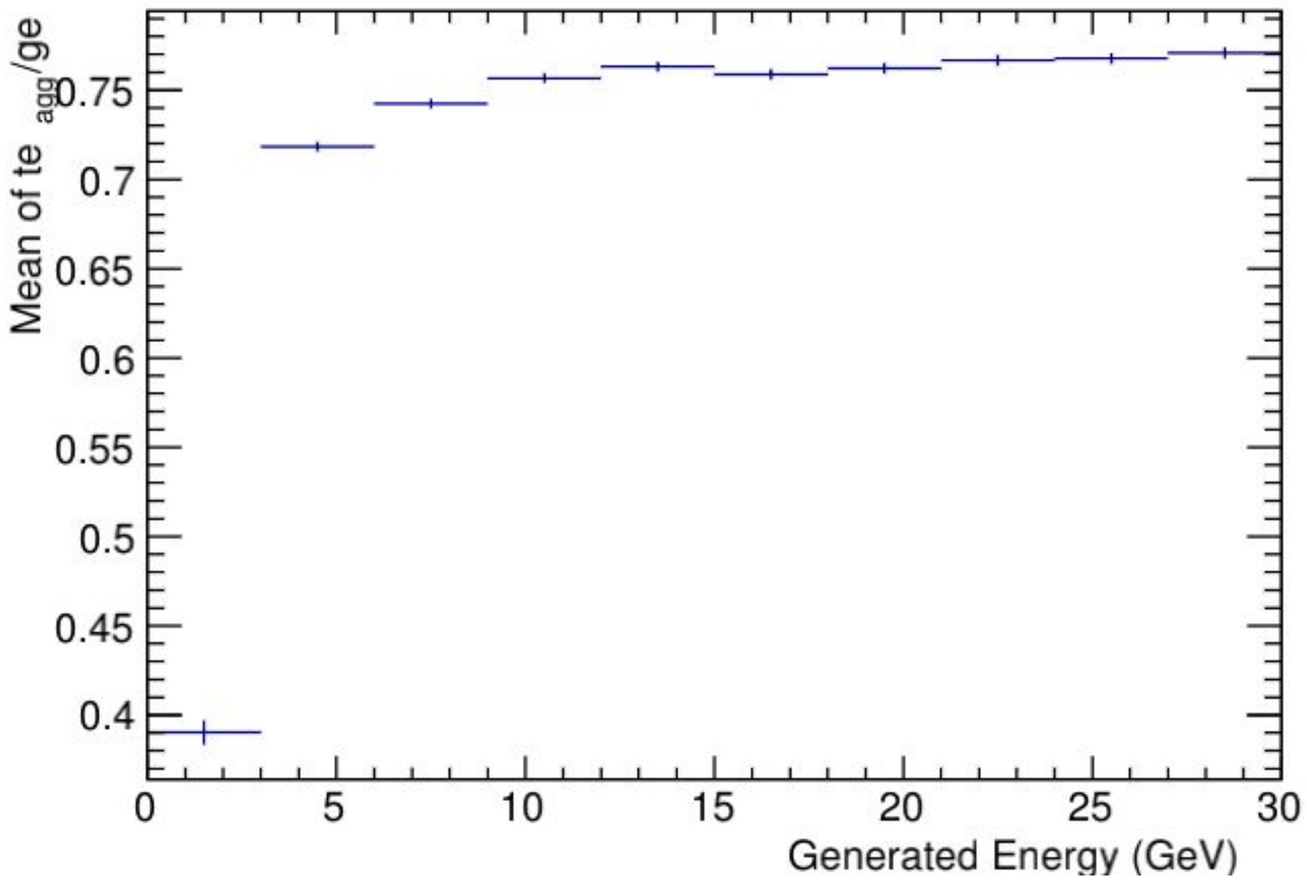
Elliptical Cut: Only the towers within the elliptical region (centered at origin) are considered for further analysis.

Dimensions:

semi-minor axis = 0.13 units
semi-major axis = 0.40 units

FEMC (e^-)

Elliptical cut on dphi vs dtheta
Explicit η cut: 1.3 to 3.3
200 MeV Energy Cut



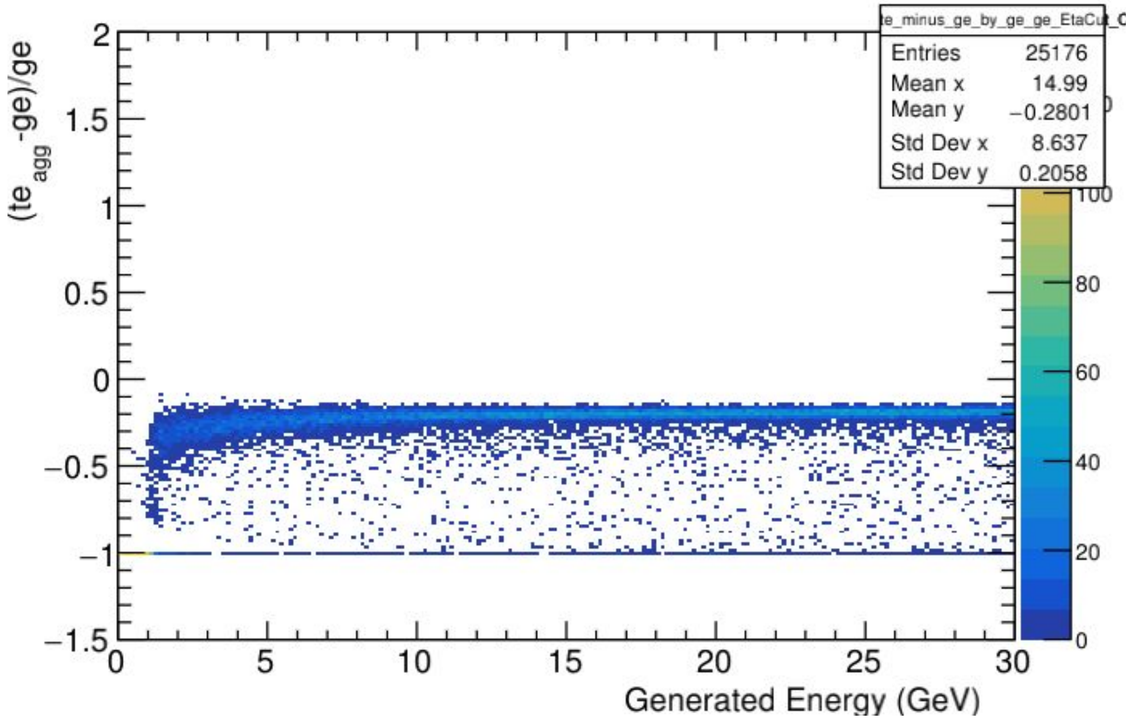
Each slice of `(te`$_{agg}$`-ge)/ge vs ge` plot will be recalibrated on the basis of dividing by a recalibration factor which equals to the Mean of `te`$_{agg}$`/ge` corresponding to that particular slice in this plot.

*The Recalibration factor for the first slice has been decided manually because the value from this plot doesn't seem to be optimum, owing to a relative surplus of low energy entries close to 200 MeV.

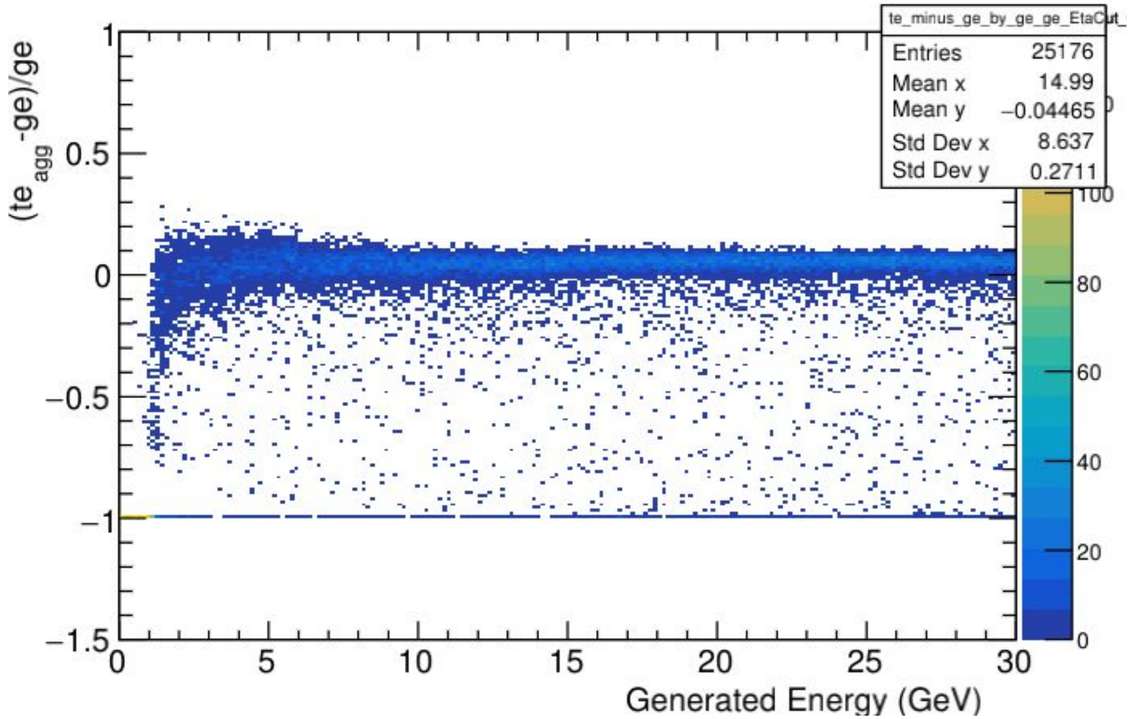
recalibrationFactor of first slice = 0.7088

FEMC (e^-)

(te_{agg}-ge)/ge vs ge
Explicit η cut: 1.3 to 3.3
200 MeV Energy Cut

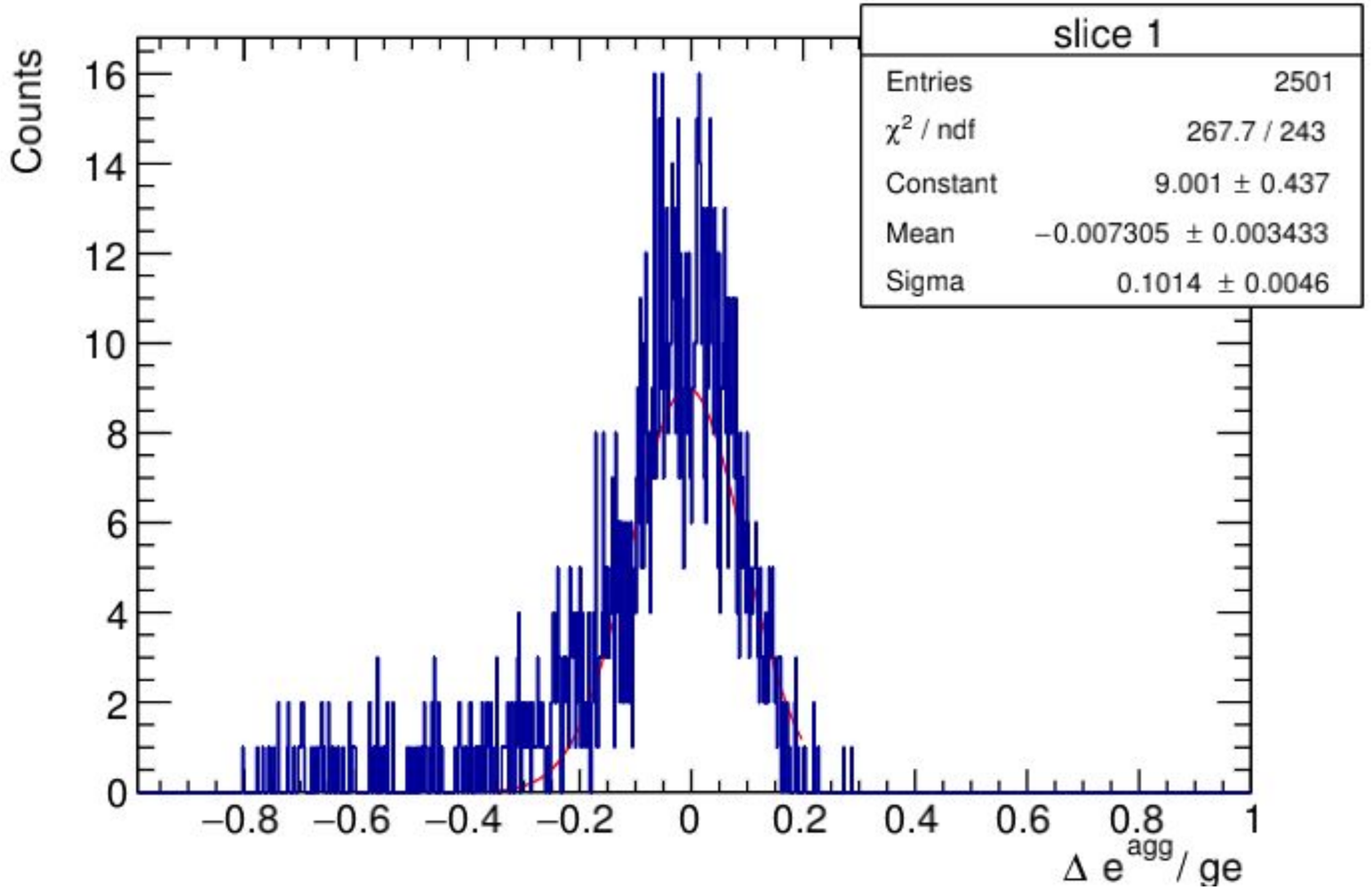


After Recalibration (te → te/recalibrationFactor)



FEMC (e^-)

(te_{agg}-ge)/ge vs ge
Gaussian fit of the first slice (0-3 GeV)



This is the gaussian fit of the first slice of the recalibrated `(te_agg-ge)/ge vs ge` plot.
(shown on the previous slide)

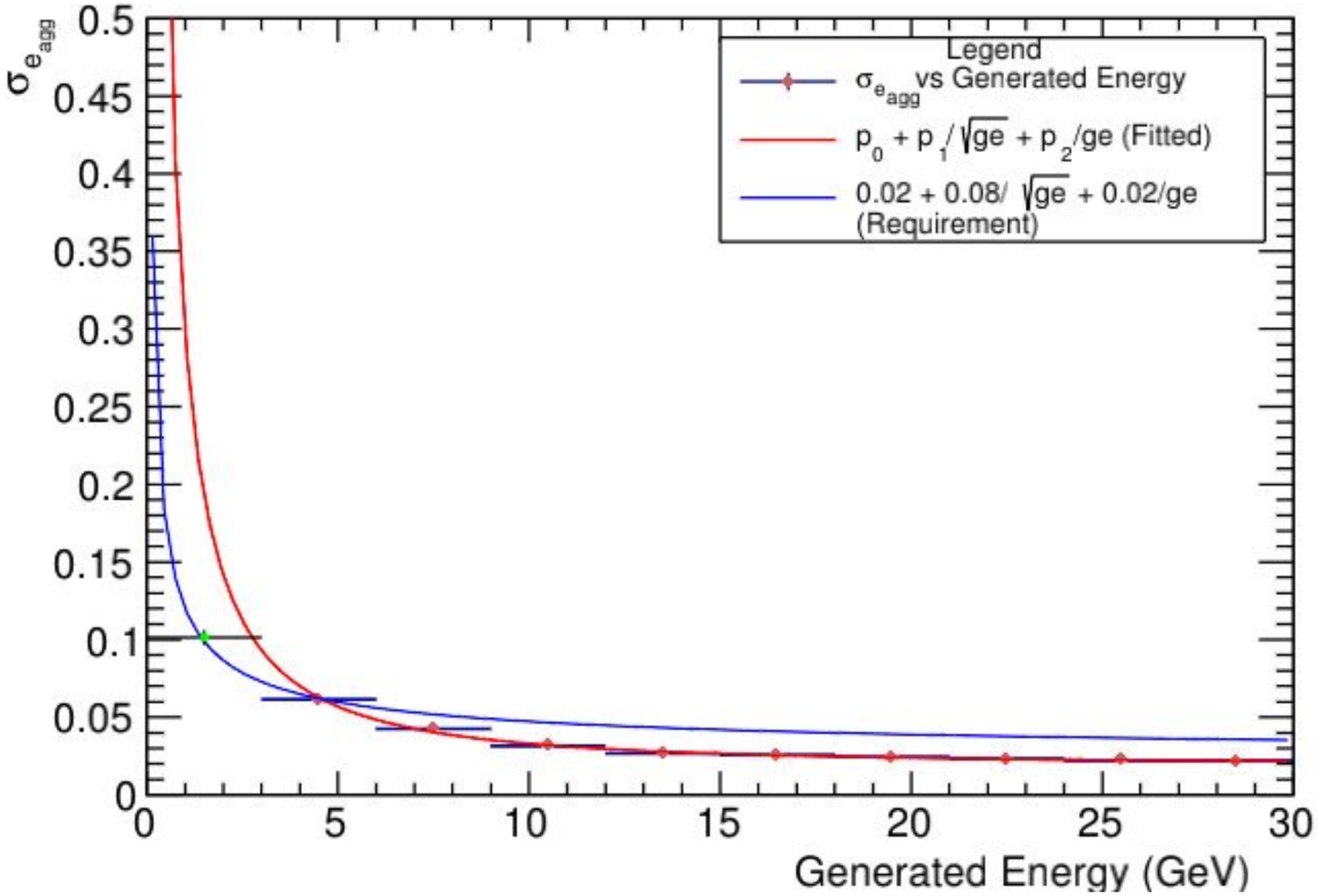
This fit has been done manually by restricting the fit range of the gaussian from -0.35 to 0.20

*All other gaussians have been fit over the entire range.

Number of bins = 1000 from -0.99 to +1.00

FEMC (e^-)

σ_e_{agg} vs ge
Explicit η cut: 1.3 to 3.3
Elliptical Cut
200 MeV Energy Cut



`σe` refers to the standard deviation of the Gaussian fitted to a slice of the recalibrated `(te`$_{agg}$`-ge)/ge vs ge` plot.
(shown on slide 26)

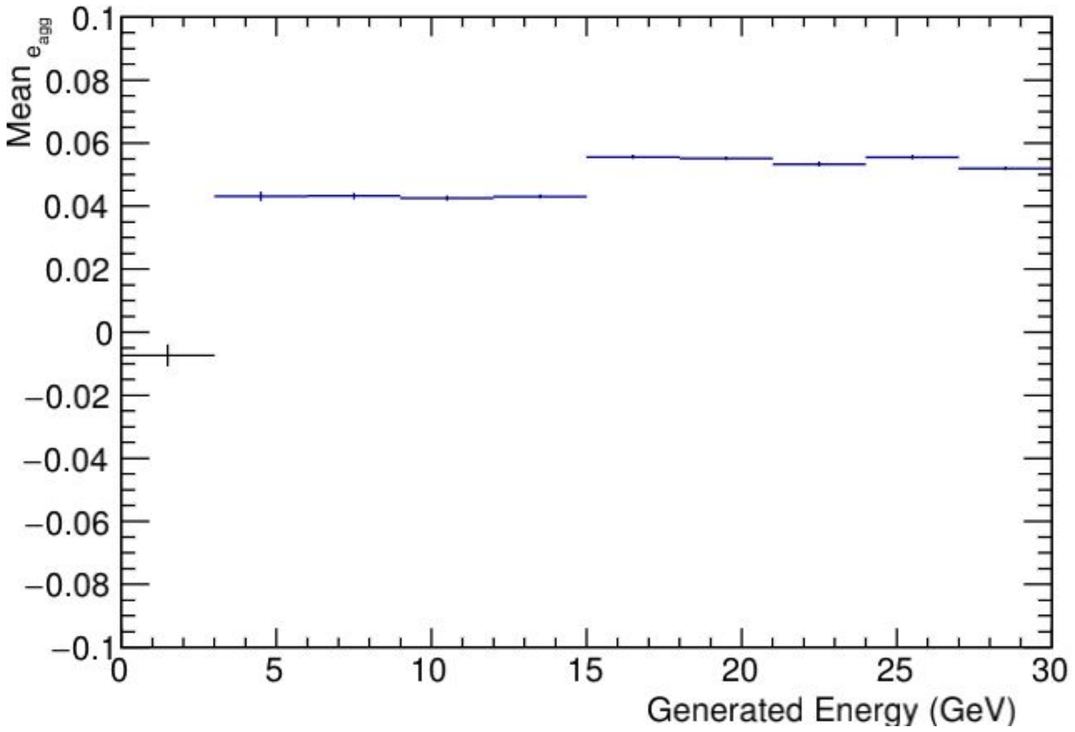
Number of bins = 10
Bin Width = 3 GeV

Fit Parameters:
p_o = (0.0278870 +- 0.00274764)
p_1 = (-0.101030 +- 0.0196019) $GeV^{0.5}$
p_2 = (0.370564 +- 0.0329895) GeV

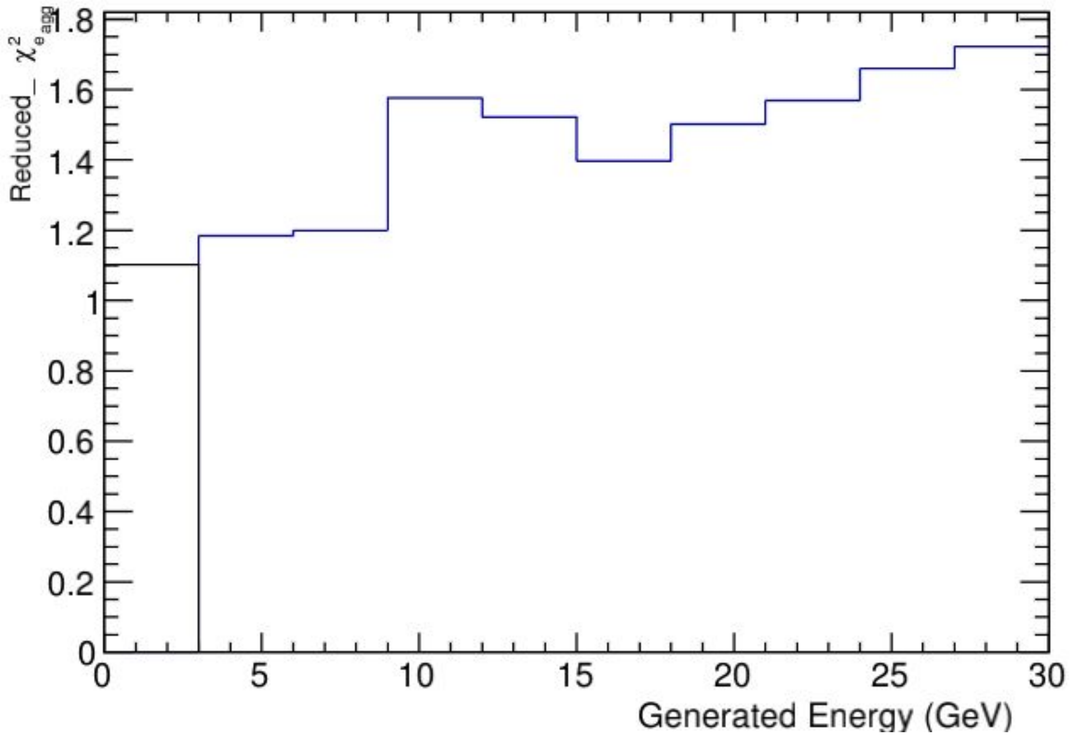
The fit does not account for the first slice. The first slice was overlaid manually over the plot.

FEMC (e^-)

Explicit η cut: 1.3 to 3.3
Elliptical cut, 200 MeV Energy Cut



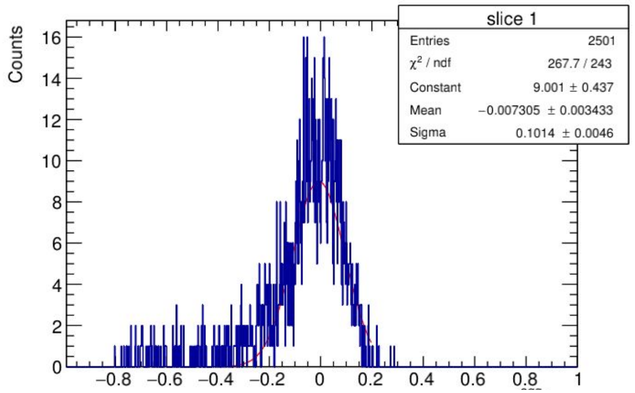
Mean of the Gaussians fitted to the slices of the recalibrated `(te`$_{agg}$`-ge)/ge vs ge` plot.

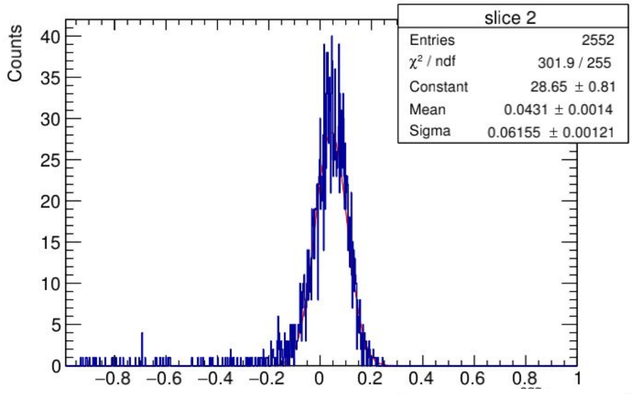


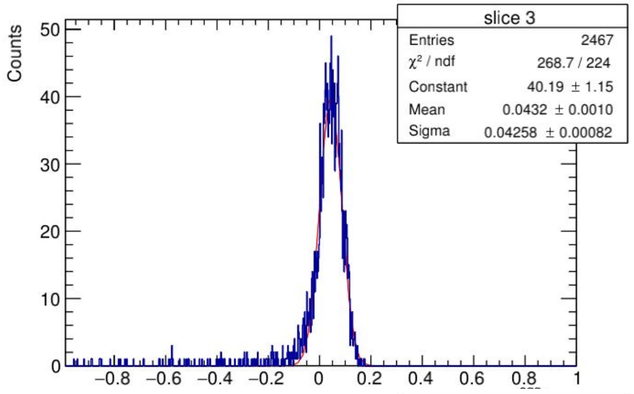
Reduced_χ2 of the Gaussians fitted to the slices of the recalibrated `(te`$_{agg}$`-ge)/ge vs ge` plot.

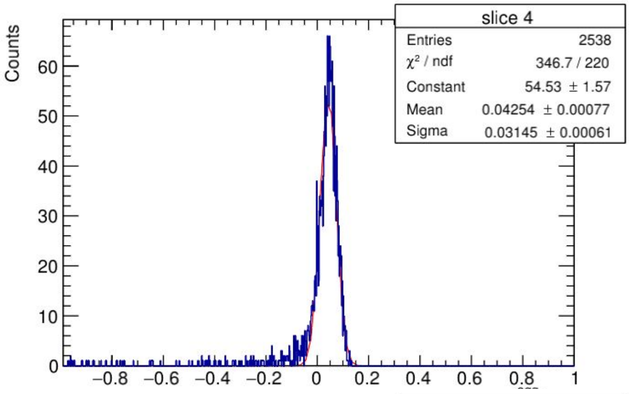
FEMC (e^-)

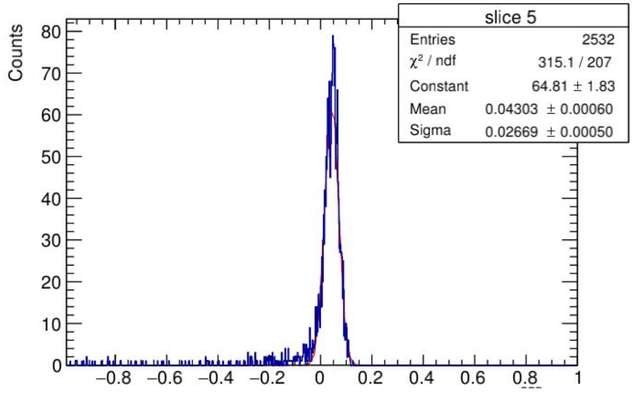
Fitted Gaussians

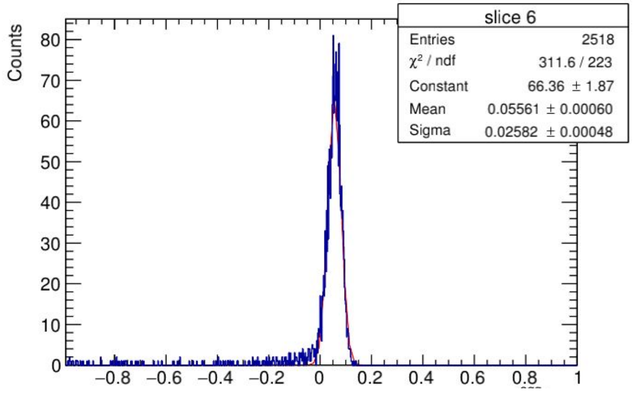


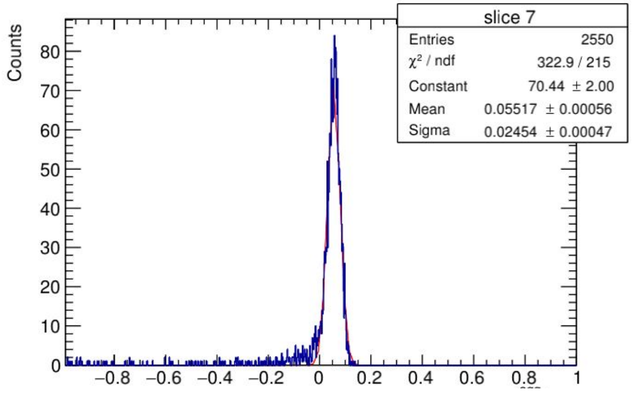


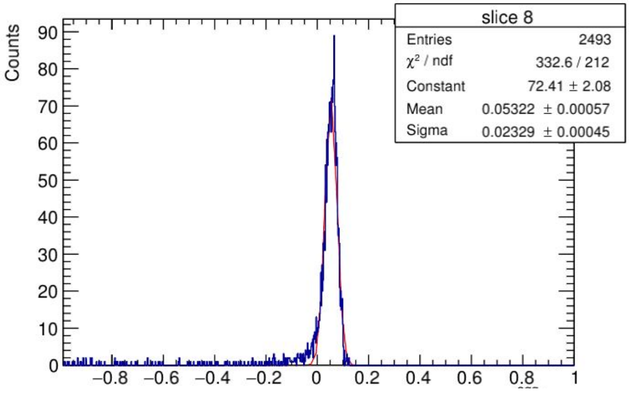


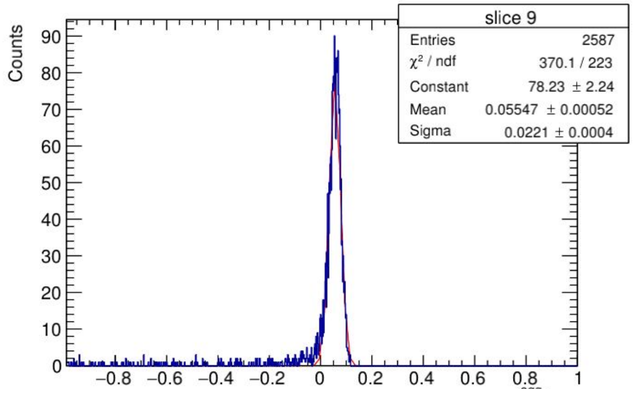


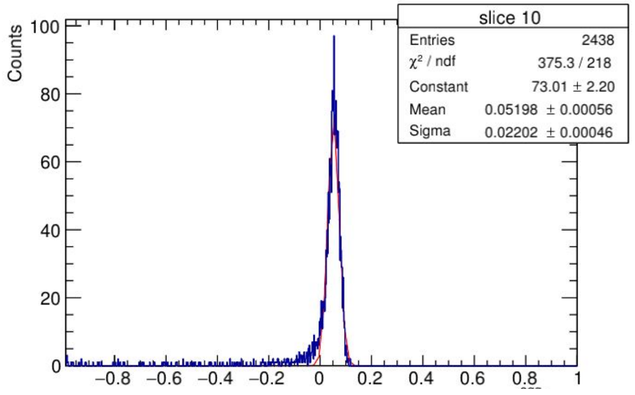










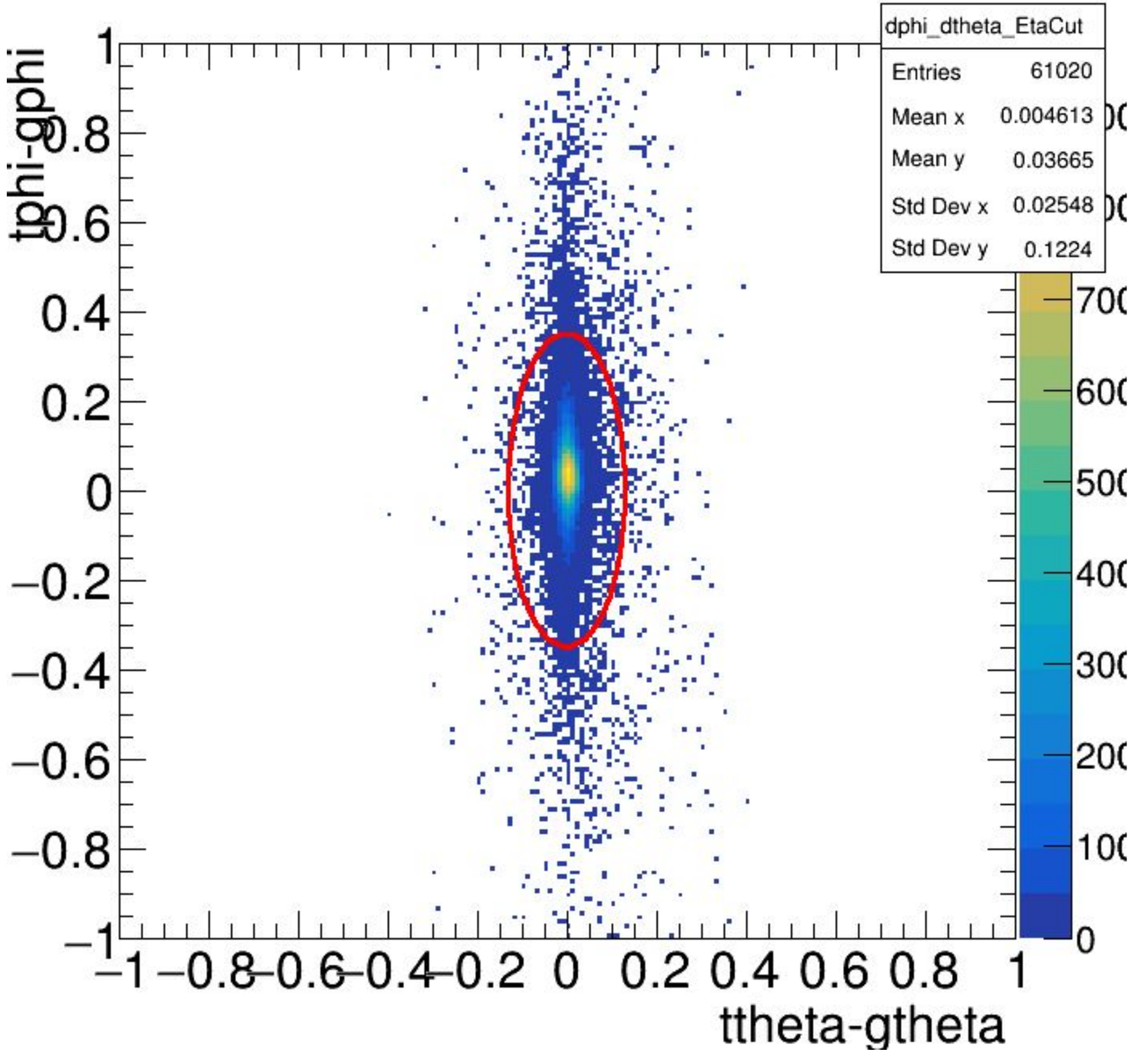


The x-axes denote $\Delta e_{agg}/ge$

FEMC + FHCAL (pi^-)

FEMC (pi^-)

Elliptical cut on dphi vs dtheta, Explicit η cut: 1.3 to 3.3, 200 MeV energy cut



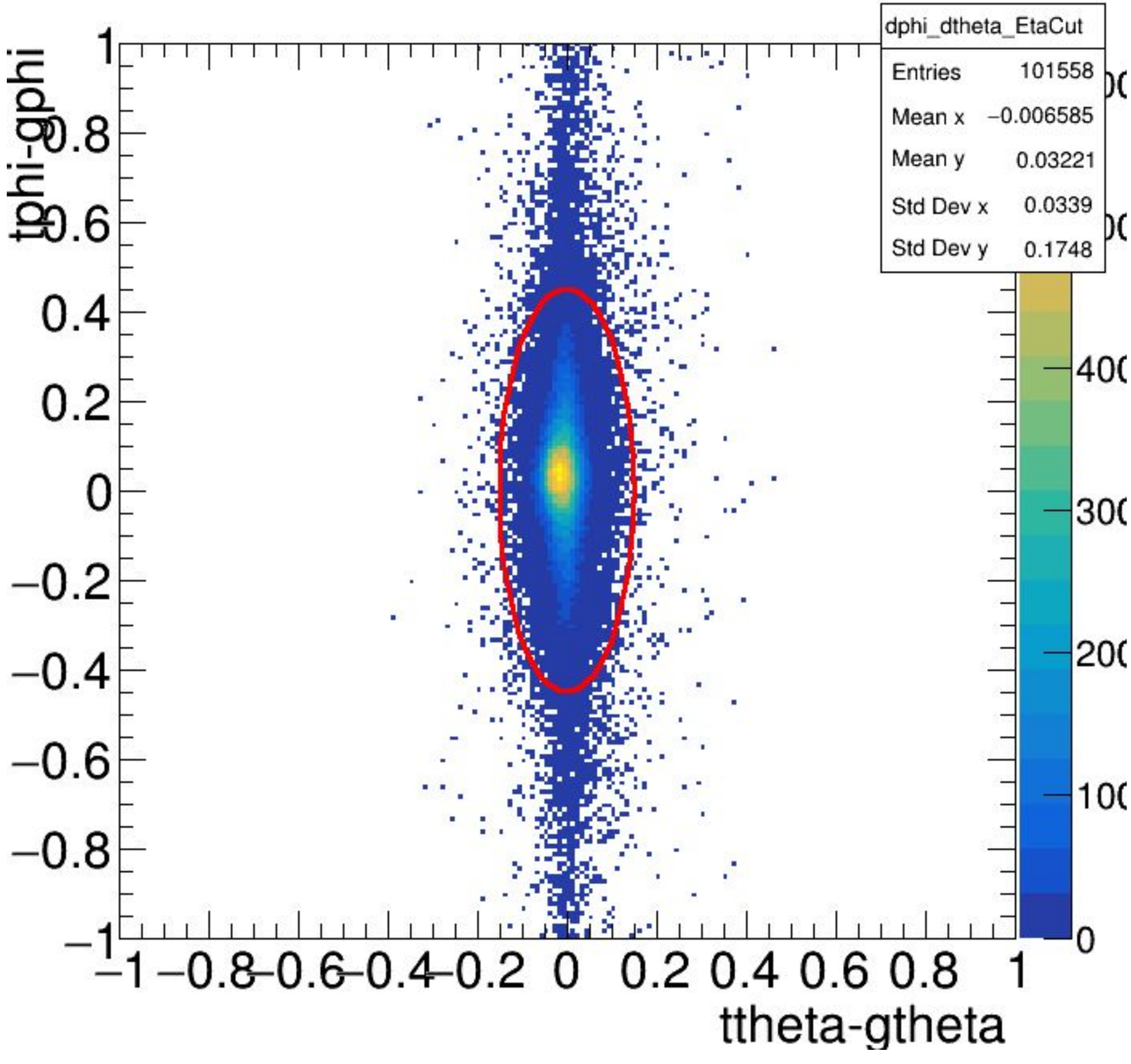
Elliptical Cut: Only the towers within the elliptical region (centered at origin) are considered for further analysis.

Dimensions:

semi-minor axis = 0.13 units
semi-major axis = 0.35 units

FHCAL (pi^-)

Elliptical cut on dphi vs dtheta, Explicit η cut: 1.3 to 3.3, 200 MeV energy cut



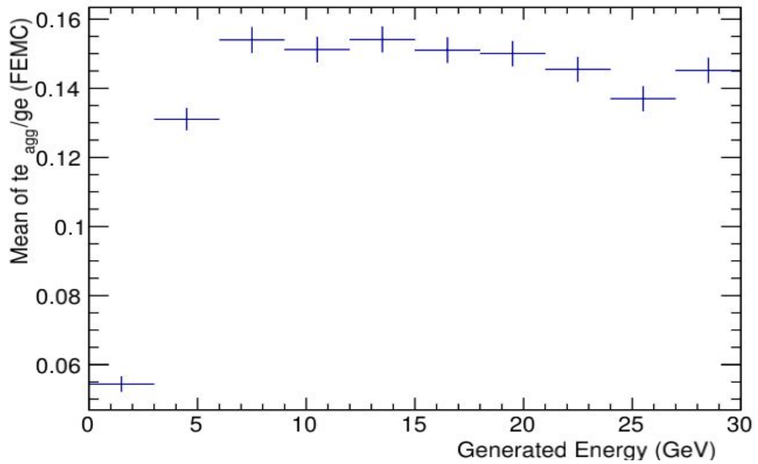
Elliptical Cut: Only the towers within the elliptical region (centered at origin) are considered for further analysis.

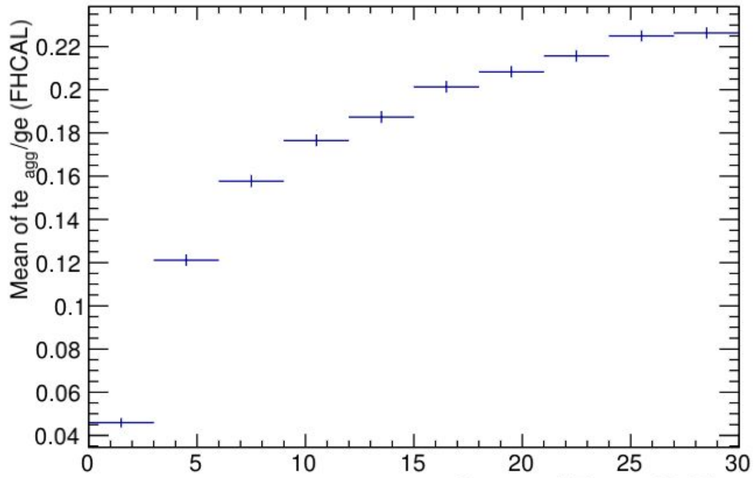
Dimensions:

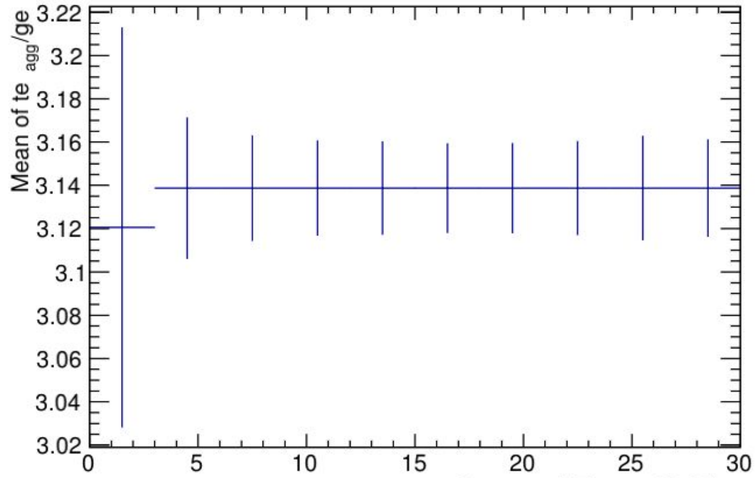
semi-minor axis = 0.15 units
semi-major axis = 0.45 units

FEMC + FHCAL (pi^-)

Explicit η cut: 1.3 to 3.3
200 MeV energy cut







recalibrationFactor of first slice = 4.5
(decided manually)

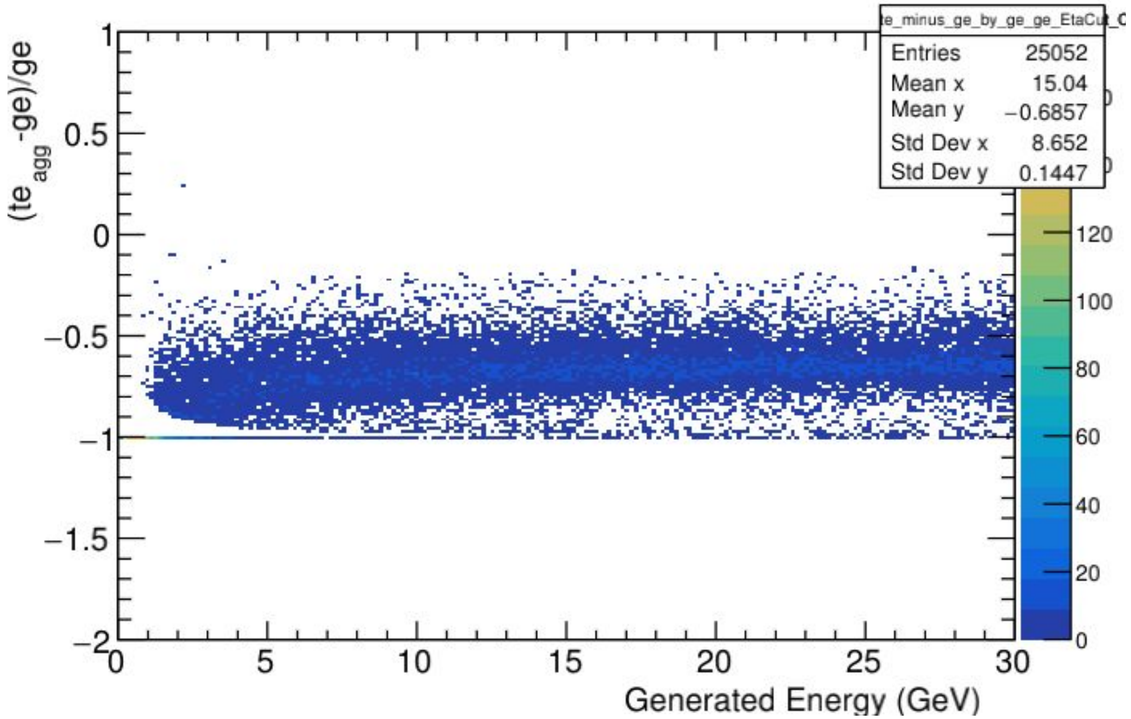
Procedure followed for recalibration:

- For individual detectors, plot `te`$_{agg}$`/ge vs ge` and use the mean values of the energy obtained for different `ge` ranges to get the scaling factor for that range. These scaling factors are the normalised mean values, that is, the mean values divided by the sum of all means (integration of steps of width 1 GeV).

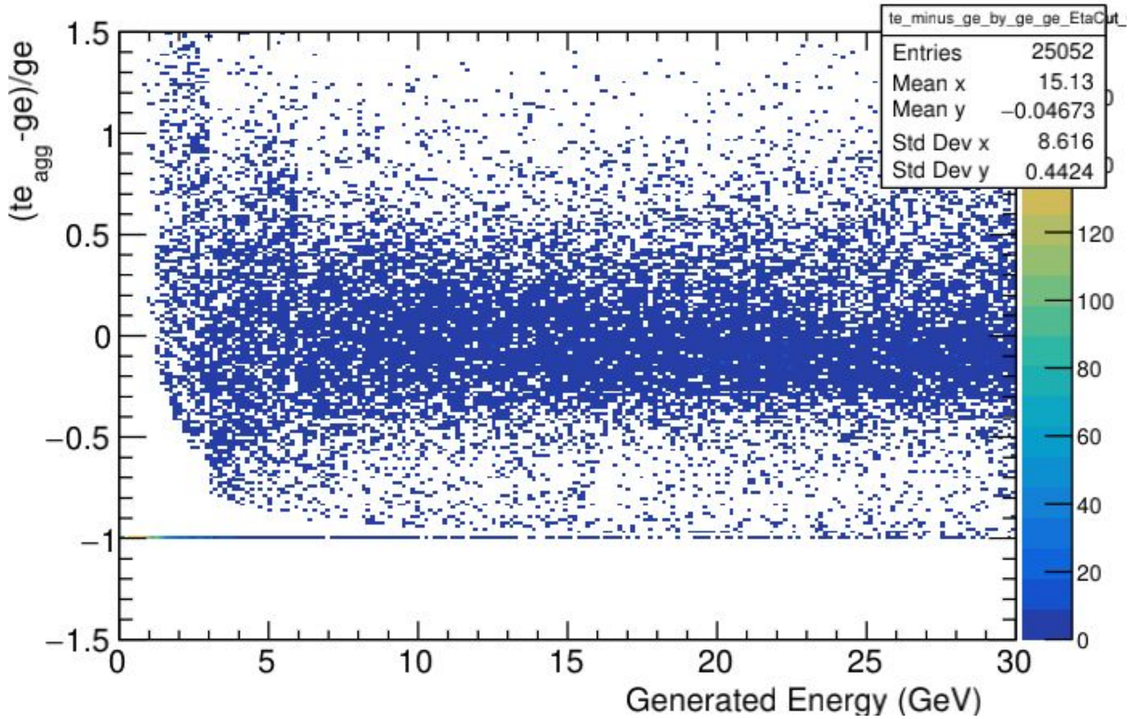
- Sum up these scaled energies to plot the overall `te`$_{agg}$`/ge vs ge` and use the mean values of this plot for different `ge` ranges (except for the first slice) as the recalibration factor for that range, applied on the above scaled energies for creating the `(te`$_{agg}$`-ge)/ge vs ge` plot.

FEMC + FHCAL (pi^-)

(te_{agg}-ge)/ge vs ge
Explicit η cut: 1.3 to 3.3
200 MeV energy cut

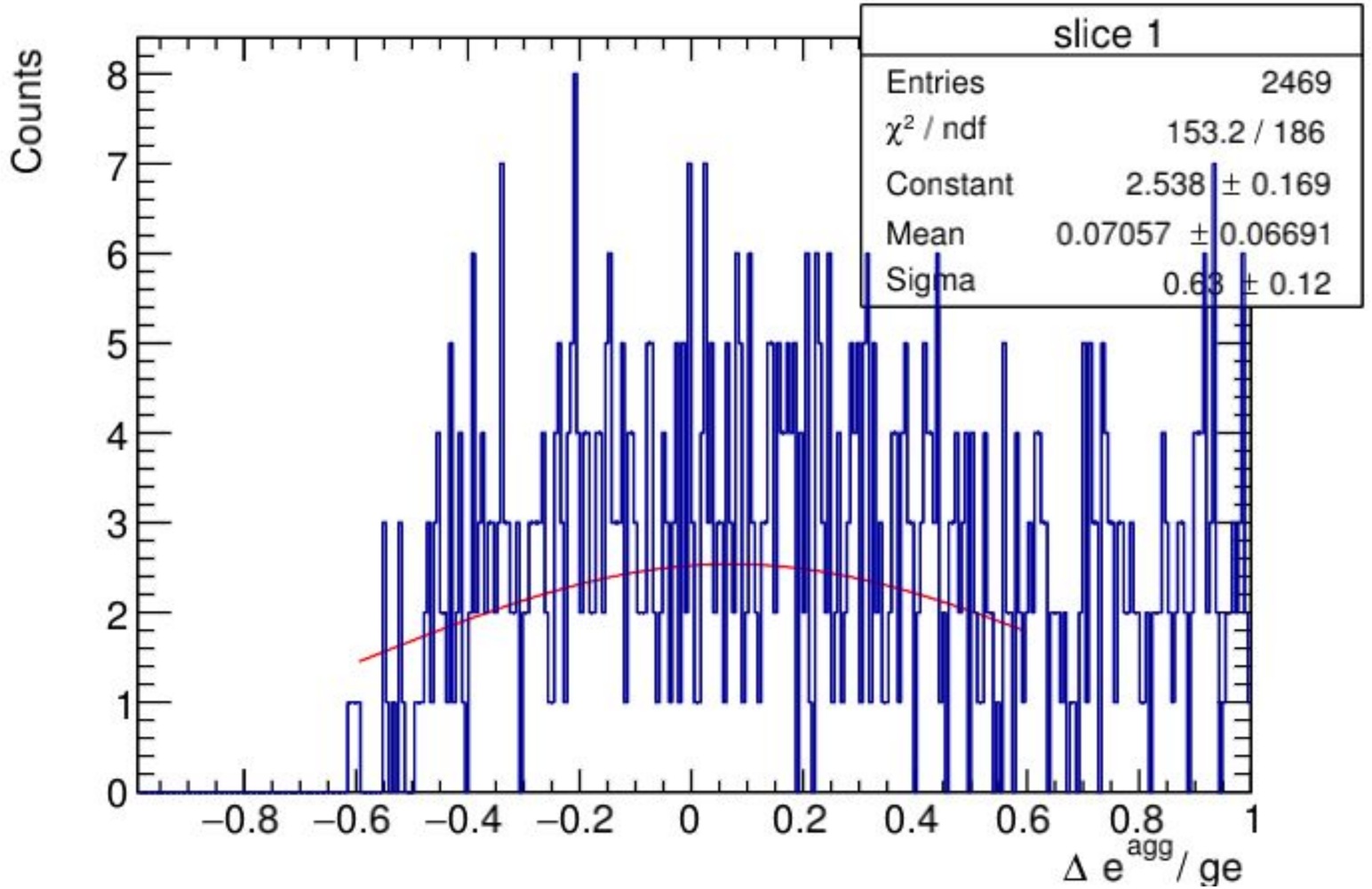


After Recalibration (te → te/recalibrationFactor{ge})



FEMC + FHCAL (pi^-)

(te_{agg}-ge)/ge vs ge
Gaussian fit of the first slice (0-2 GeV)



This is the gaussian fit of the first slice of the recalibrated `(te_agg-ge)/ge vs ge` plot.
(shown on the previous slide)

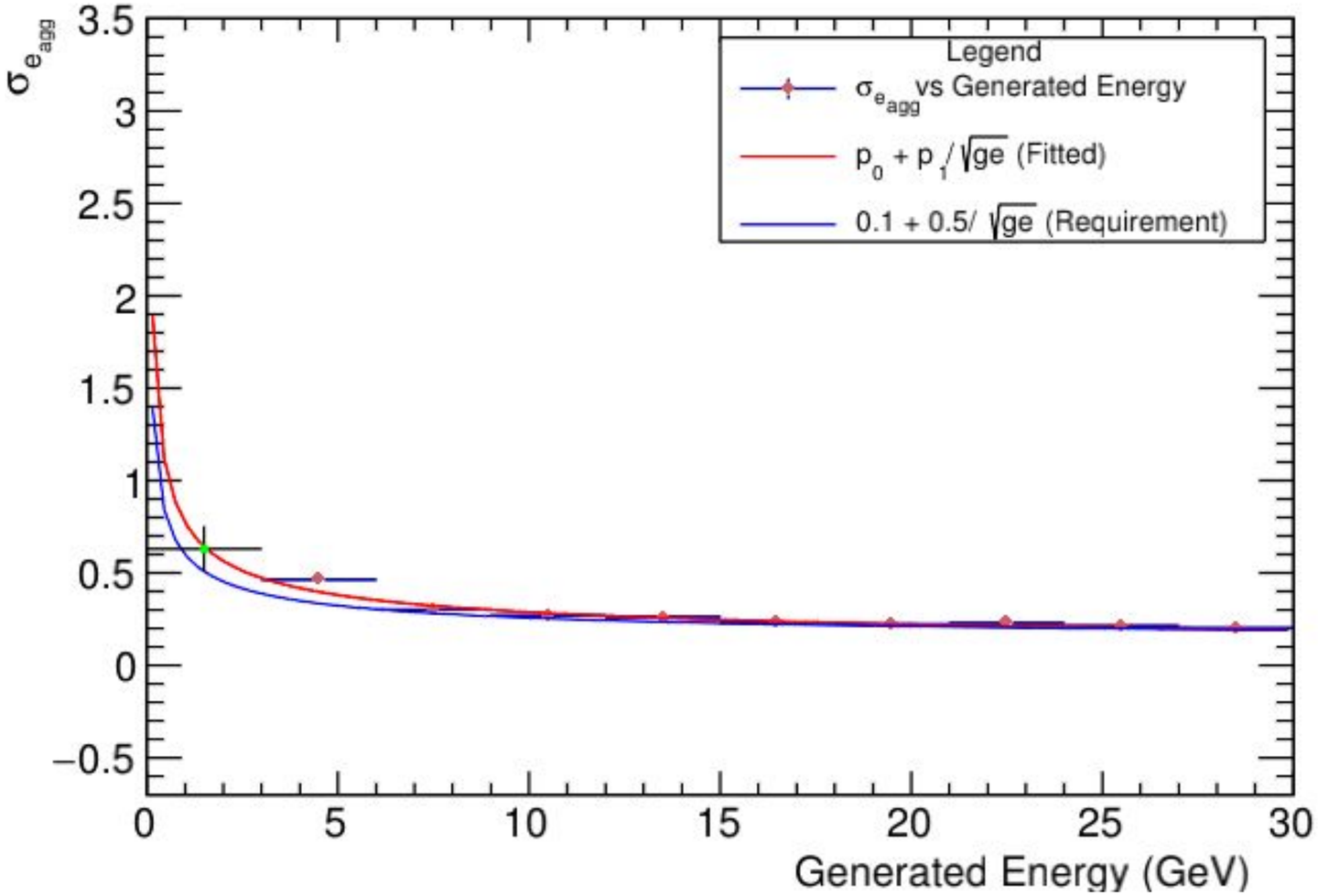
This fit has been done manually by restricting the fit range of the gaussian from -0.6 to 0.6

*All other gaussians have been fit over the entire range.

Number of bins = 350 from -0.99 to +1.00

FEMC + FHCAL (pi^-)

σ_e_{agg} vs ge
Explicit η cut: 1.3 to 3.3
Elliptical cuts
200 MeV energy cut



`σe` refers to the standard deviation of the Gaussian fitted to a slice of the recalibrated `(te`$_{agg}$`-ge)/ge vs ge` plot.
(shown on the previous slide)

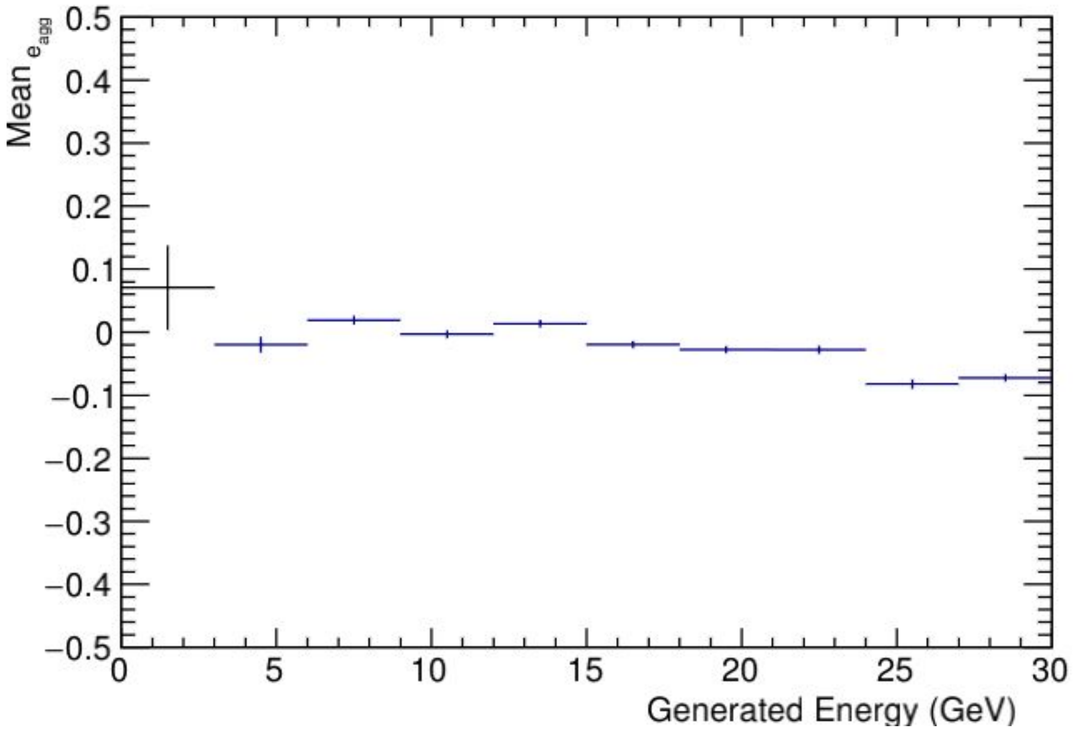
Number of bins = 10
Bin Width = 3 GeV

Fit Parameters:
p_o = (0.0647631 +- 0.00973593)
p_1 = (0.707302 +- 0.0352042) $GeV^{0.5}$

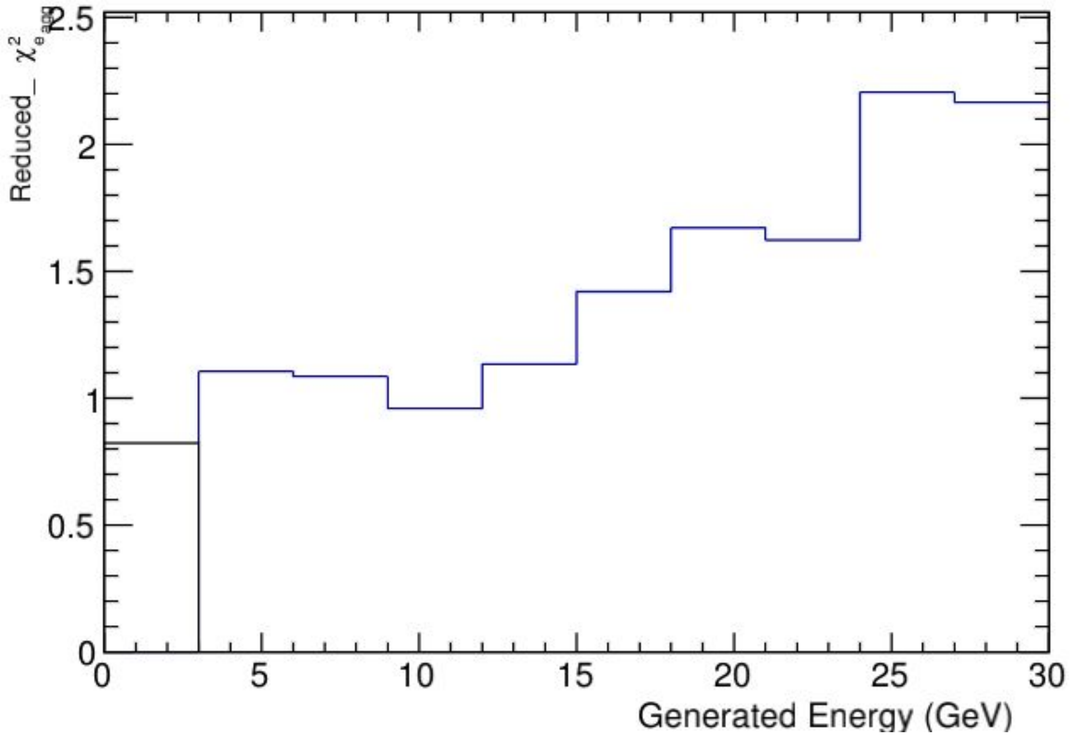
The fit does not account for the first slice. The first slice was overlaid manually over the plot.

FEMC + FHCAL (pi^-)

Explicit η cut: 1.3 to 3.3
Elliptical Cuts
200 MeV energy cut



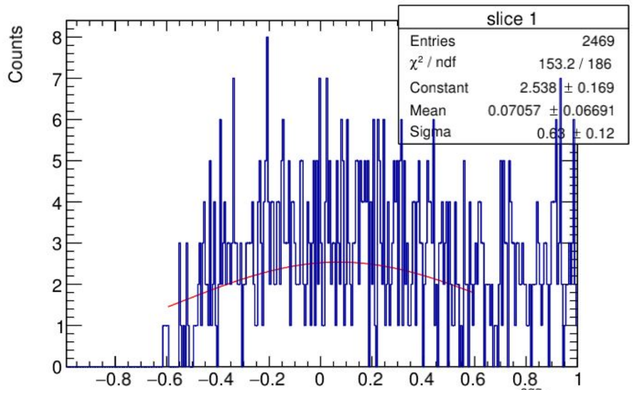
Mean of the Gaussians fitted to the slices of the recalibrated `(te`$_{agg}$`-ge)/ge vs ge` plot.

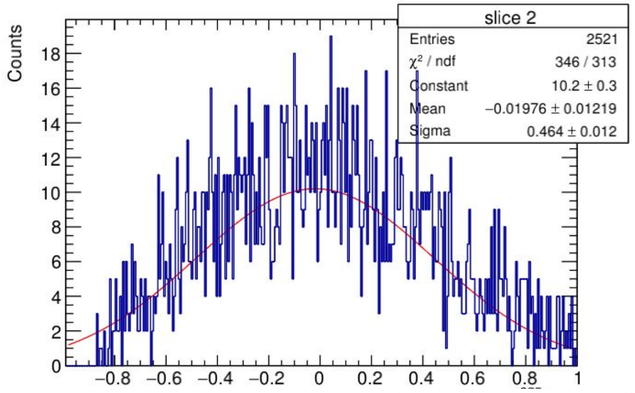


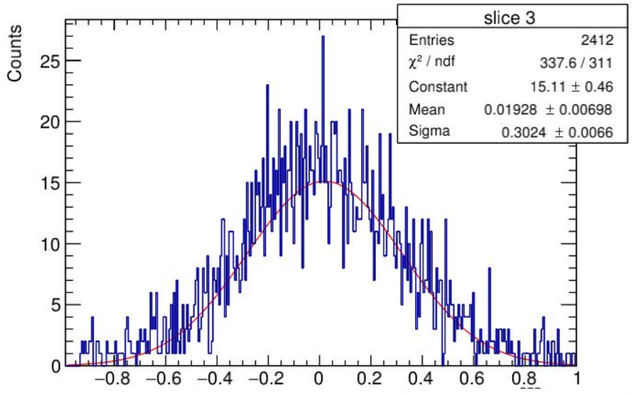
Reduced_χ2 of the Gaussians fitted to the slices of the recalibrated `(te`$_{agg}$`-ge)/ge vs ge` plot.

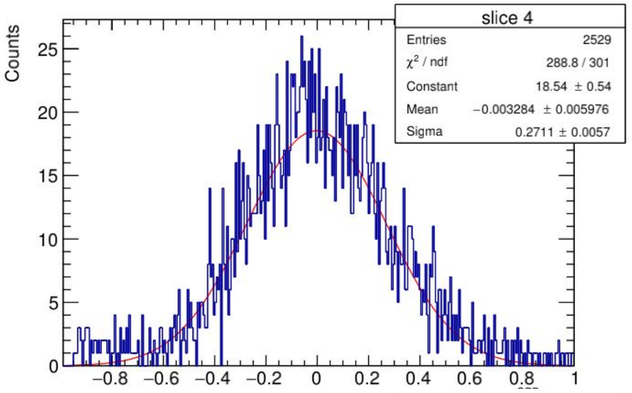
FEMC + FHCAL (pi^-)

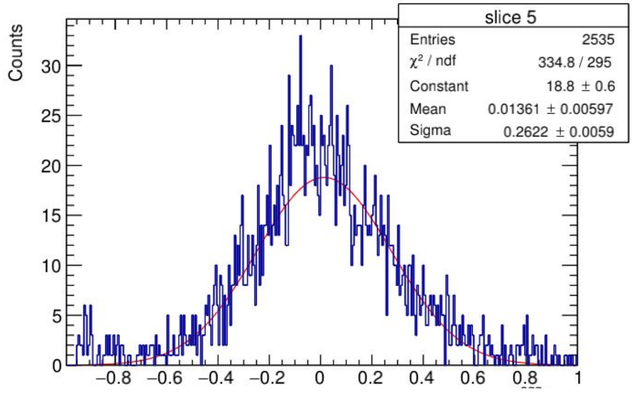
Fitted Gaussians

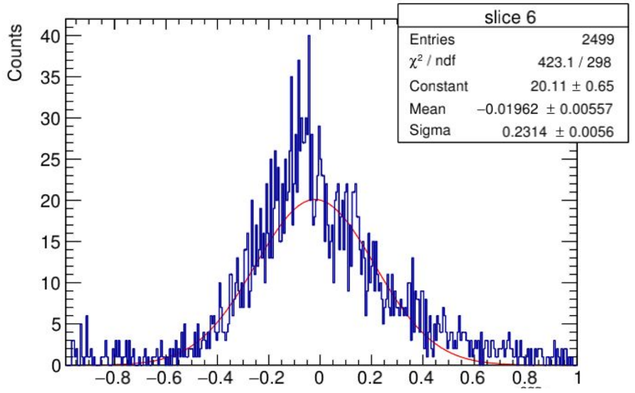


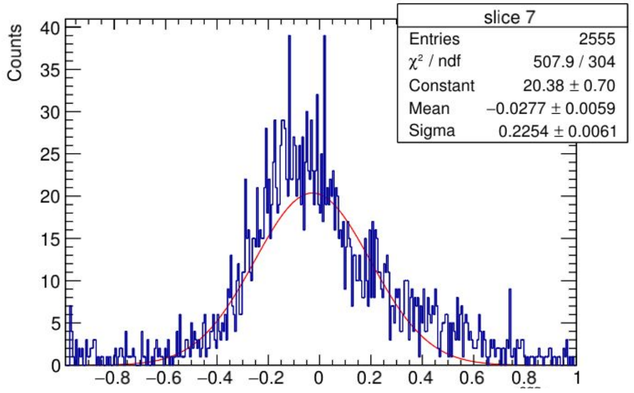


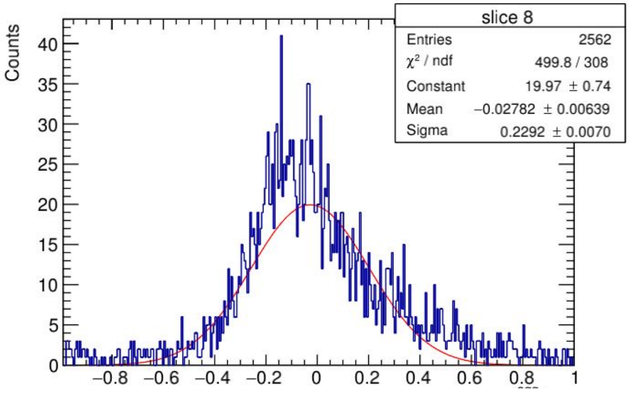


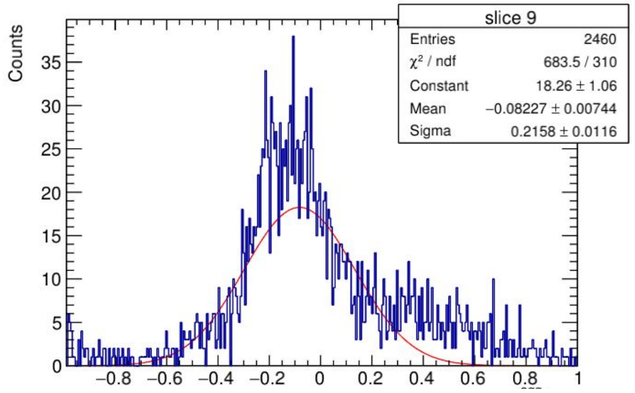


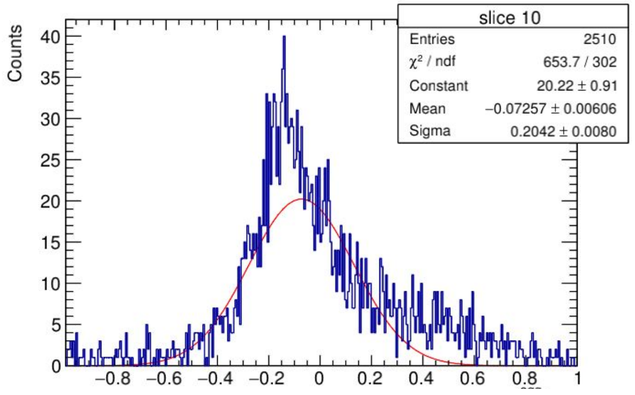










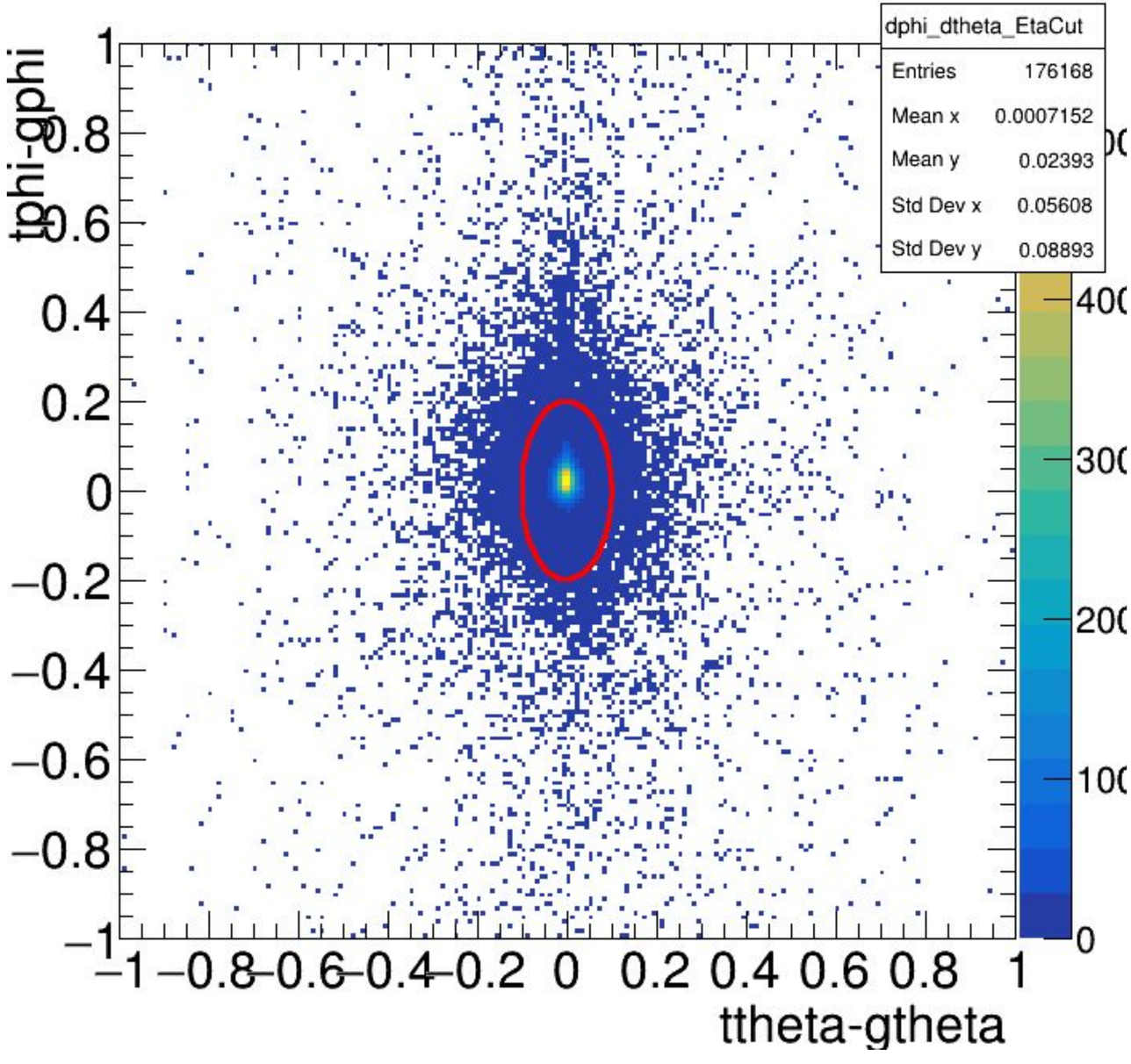


The x-axes denote $\Delta e_{agg}/ge$

CEMC + HCALIN + HCALOUT (pi^-)

CEMC (pi^-)

Elliptical cut on dphi vs dtheta, Explicit η cut: -1.1 to 1.1, 200 MeV energy cut



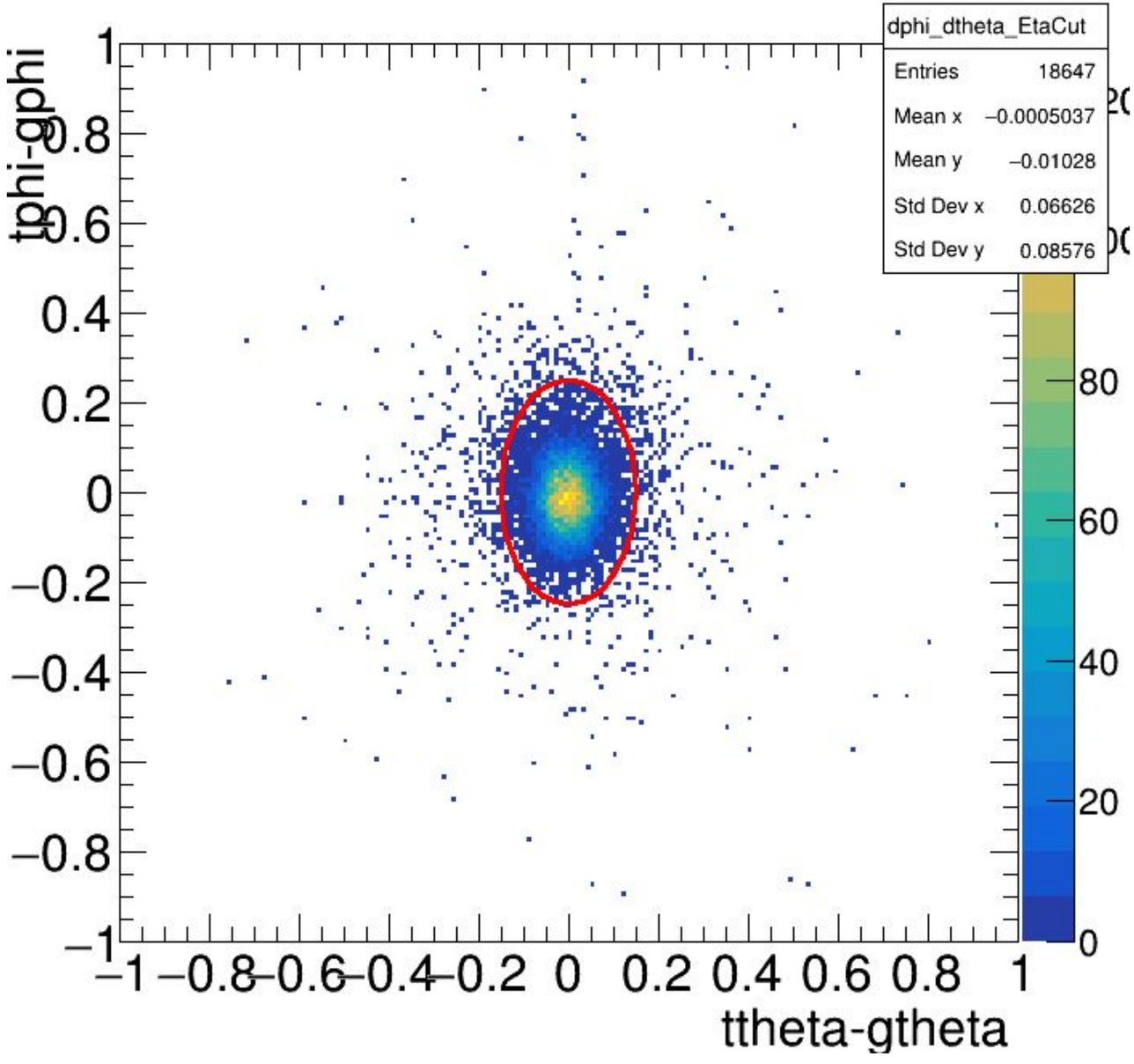
Elliptical Cut: Only the towers within the elliptical region (centered at origin) are considered for further analysis.

Dimensions:

semi-minor axis = 0.10 units
semi-major axis = 0.20 units

HCALIN (pi^-)

Elliptical cut on dphi vs dtheta, Explicit η cut: -1.1 to 1.1, 200 MeV energy cut



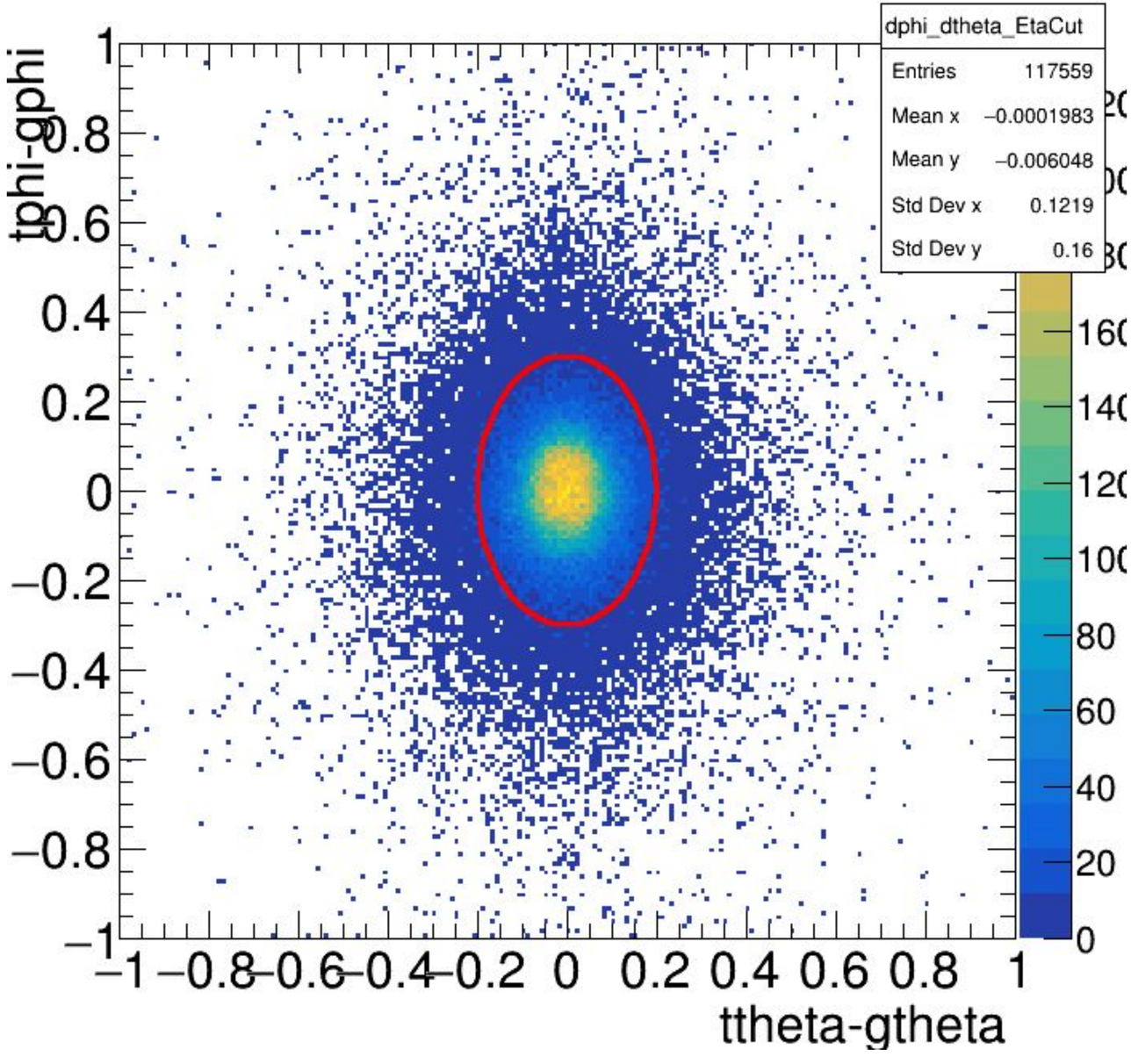
Elliptical Cut: Only the towers within the elliptical region (centered at origin) are considered for further analysis.

Dimensions:

semi-minor axis = 0.15 units
semi-major axis = 0.25 units

HCALOUT (pi^-)

Elliptical cut on dphi vs dtheta, Explicit η cut: -1.1 to 1.1, 200 MeV energy cut



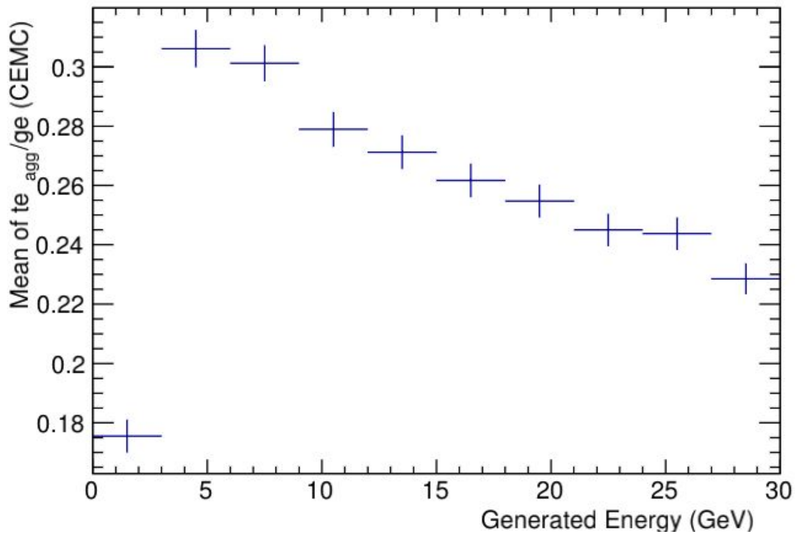
Elliptical Cut: Only the towers within the elliptical region (centered at origin) are considered for further analysis.

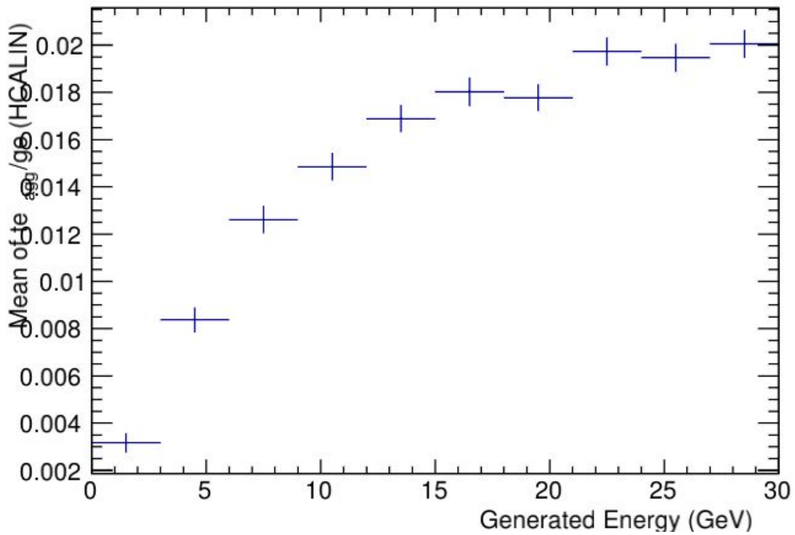
Dimensions:

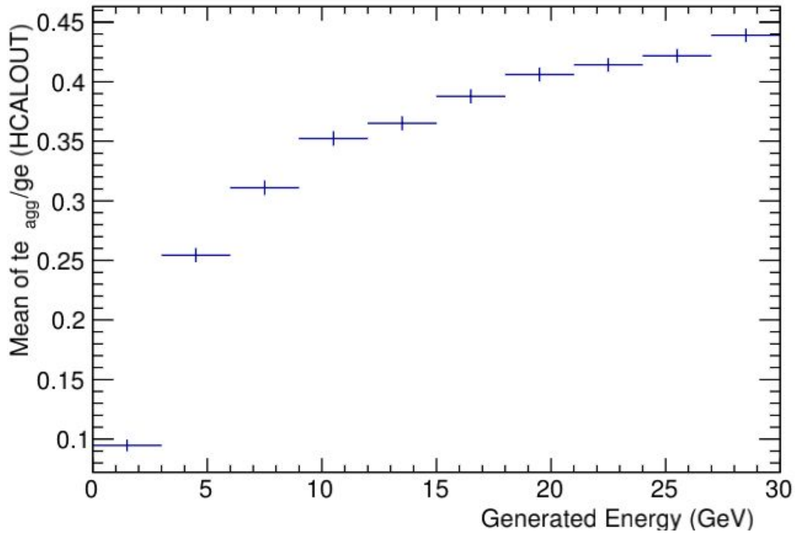
semi-minor axis = 0.20 units
semi-major axis = 0.30 units

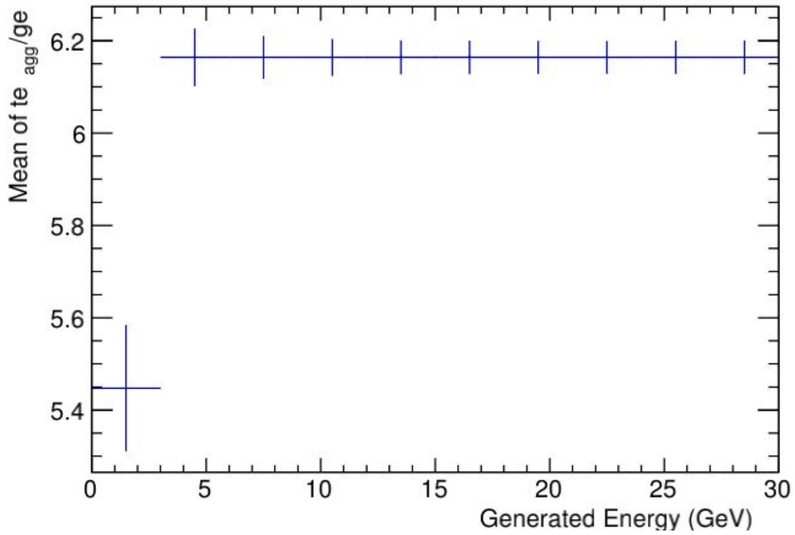
CEMC + HCALIN + HCALOUT (pi^-)

Explicit η cut: -1.1 to 1.1
200 MeV energy cut





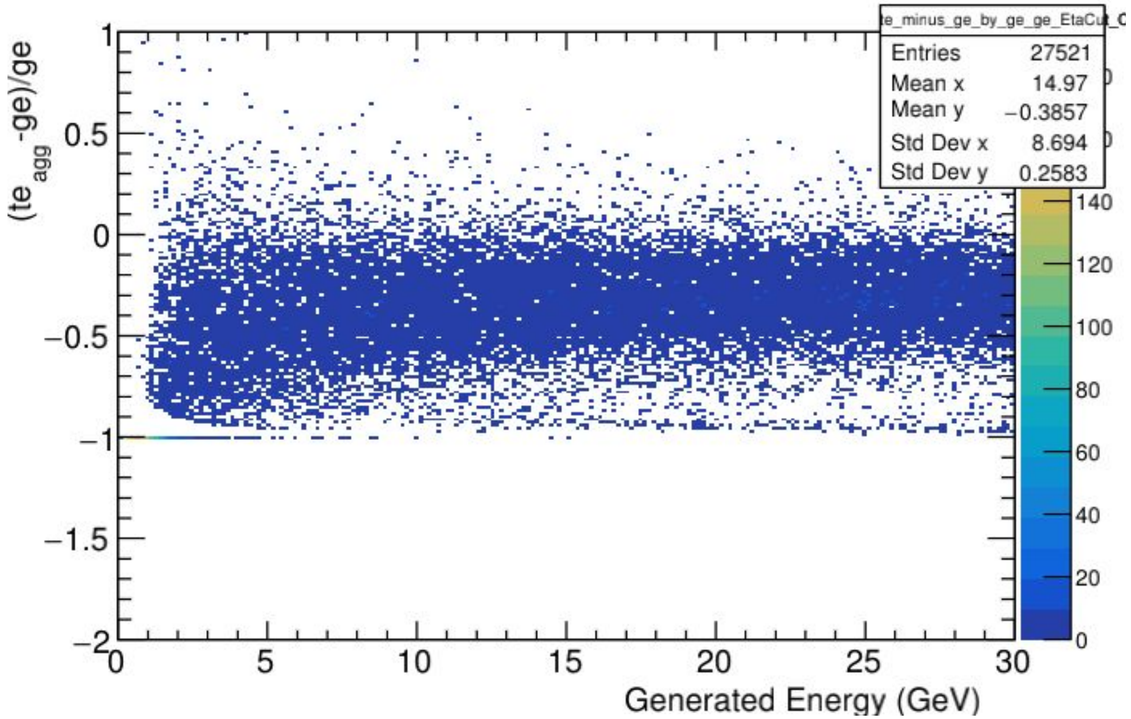




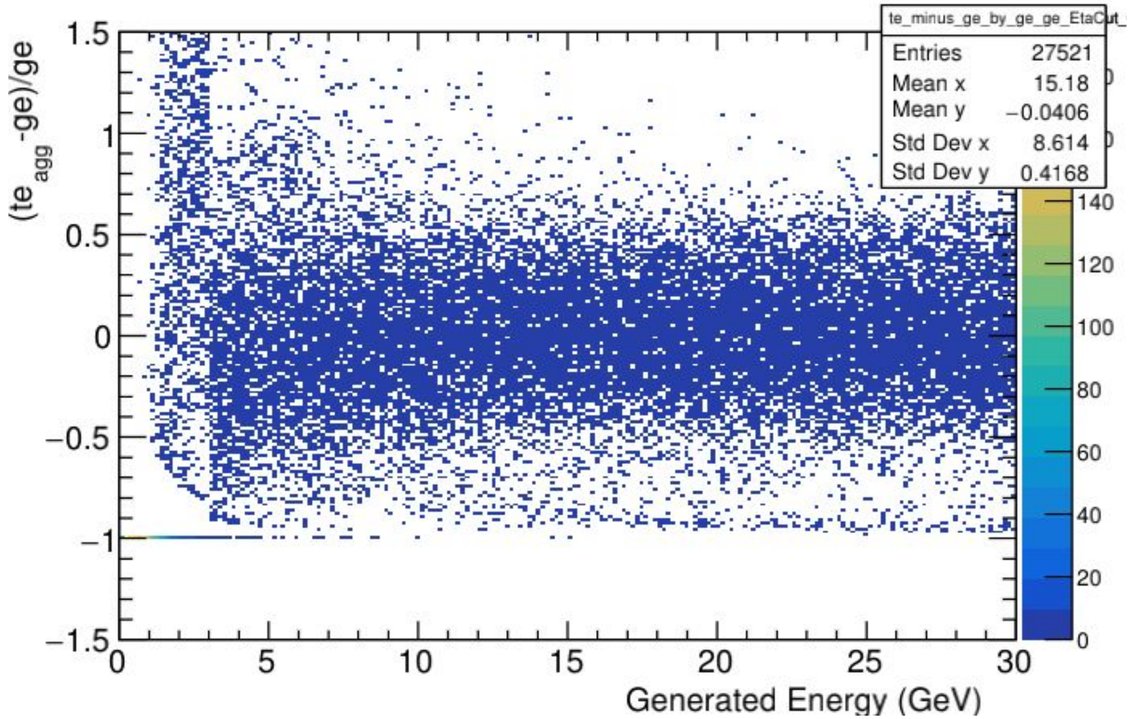
Procedure followed for recalibration: Same as that for FEMC + FHCAL

CEMC + HCALIN + HCALOUT (pi^-)

(te_{agg}-ge)/ge vs ge
Explicit η cut: -1.1 to 1.1
200 MeV energy cut

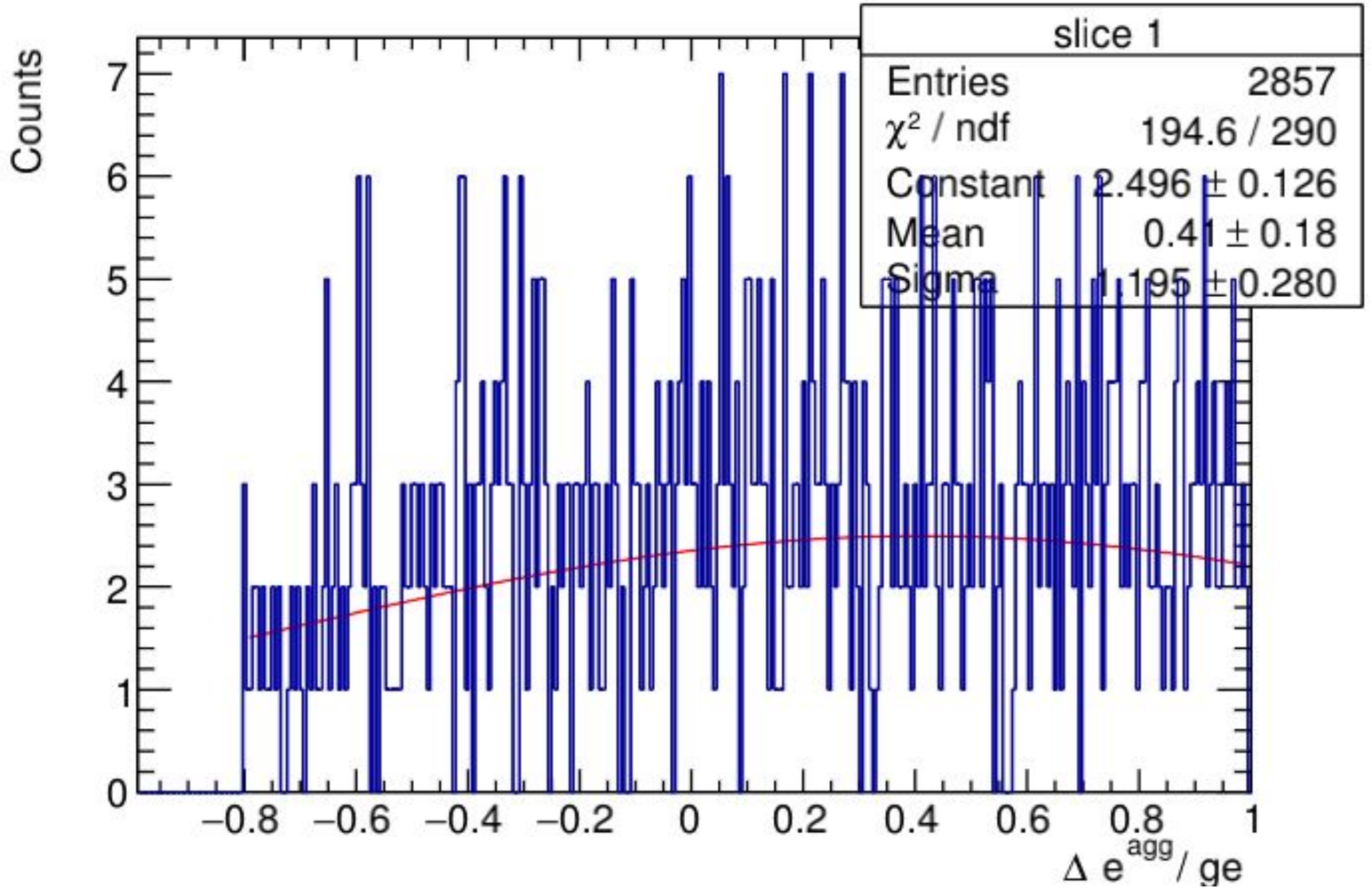


After Recalibration (te → te/recalibrationFactor{ge})



CEMC + HCALIN + HCALOUT (pi^-)

(te_{agg}-ge)/ge vs ge
Gaussian fit of the first slice (0-3 GeV)



This is the gaussian fit of the first slice of the recalibrated `(te_agg-ge)/ge vs ge` plot.
(shown on the previous slide)

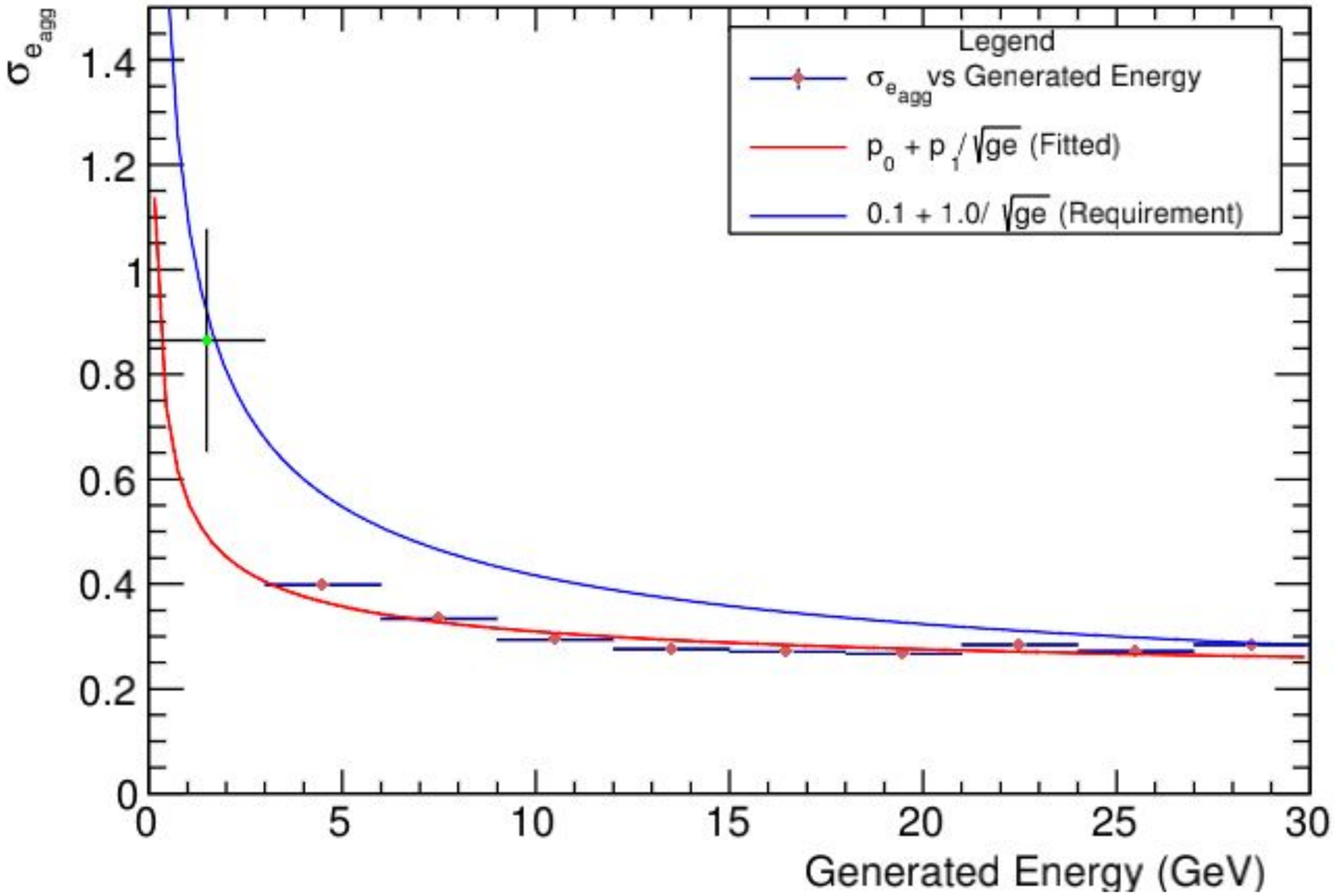
This fit has been done manually by restricting the fit range of the gaussian from -0.80 to 1.00

*All other gaussians have been fit over the entire range.

Number of bins = 350 from -0.99 to +1.00

CEMC + HCALIN + HCALOUT (pi^-)

σ_e_{agg} vs ge
Explicit η cut: -1.1 to 1.1
Elliptical cuts
200 MeV energy cut



`σe` refers to the standard deviation of the Gaussian fitted to a slice of the recalibrated `(te_agg-ge)/ge vs ge` plot.
(shown on the previous slide)

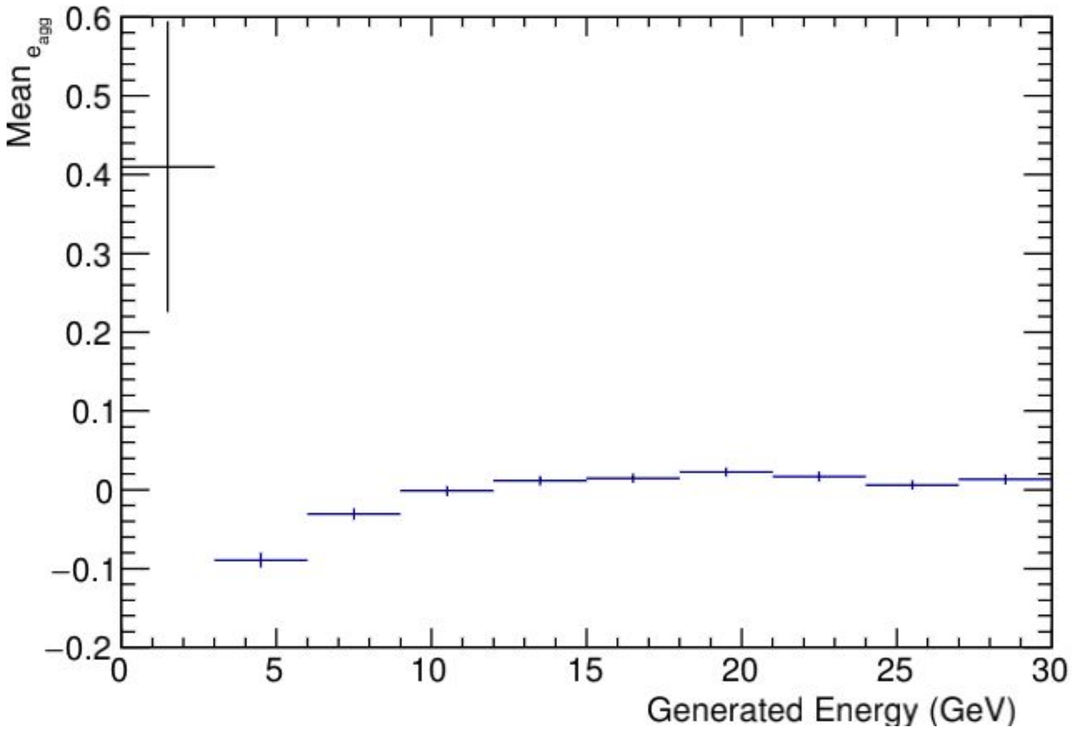
Number of bins = 10
Bin Width = 3 GeV

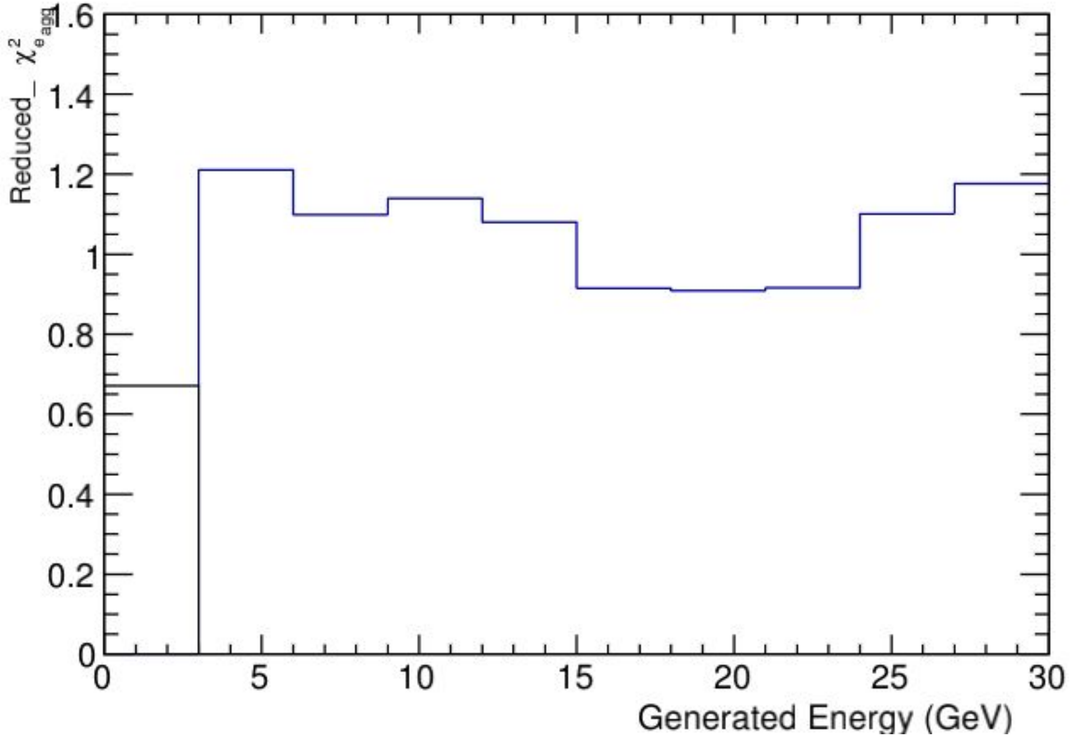
Fit Parameters:
p_o = (0.193736 +- 0.00725664)
p_1 = (0.365402 +- 0.0277798) $GeV^{0.5}$

The fit does not account for the first slice. The first slice was overlaid manually over the plot.

CEMC + HCALIN + HCALOUT (pi^-)

Explicit η cut: -1.1 to 1.1
Elliptical cuts
200 MeV energy cut



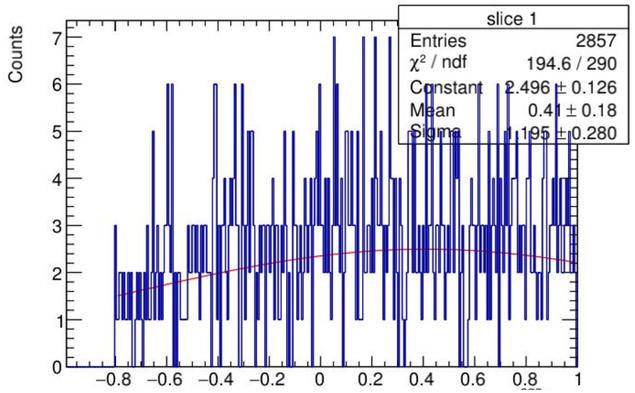


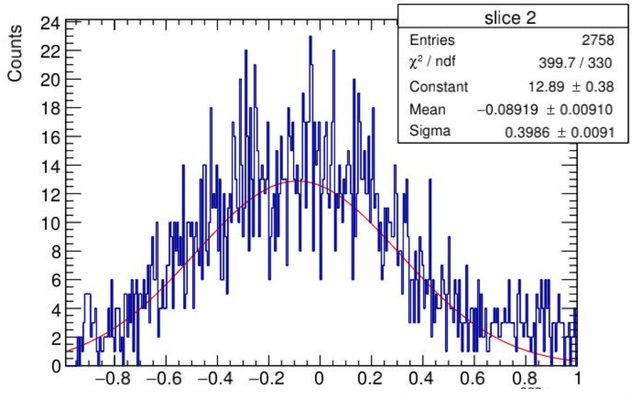
Mean of the Gaussians fitted to the slices of the recalibrated `(te`$_{agg}$`-ge)/ge vs ge` plot.

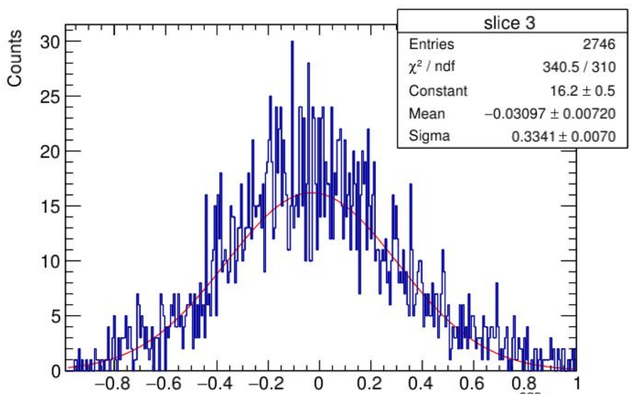
Reduced_χ2 of the Gaussians fitted to the slices of the recalibrated `(te`$_{agg}$`-ge)/ge vs ge` plot.

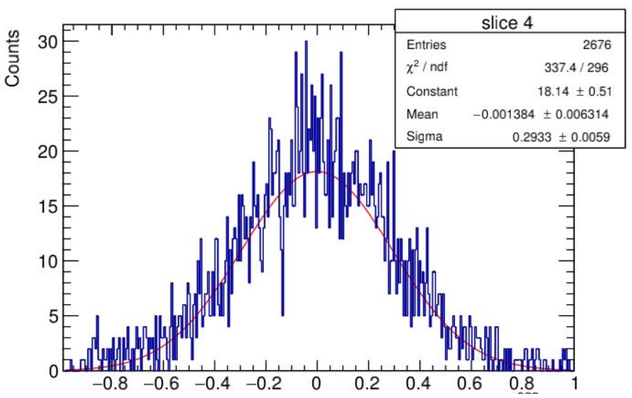
CEMC + HCALIN + HCALOUT (pi^-)

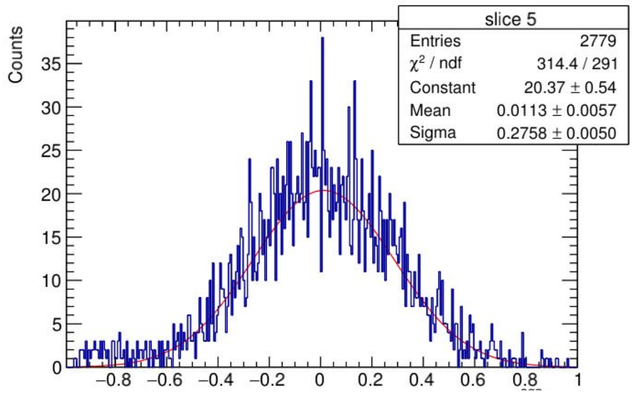
Fitted Gaussians

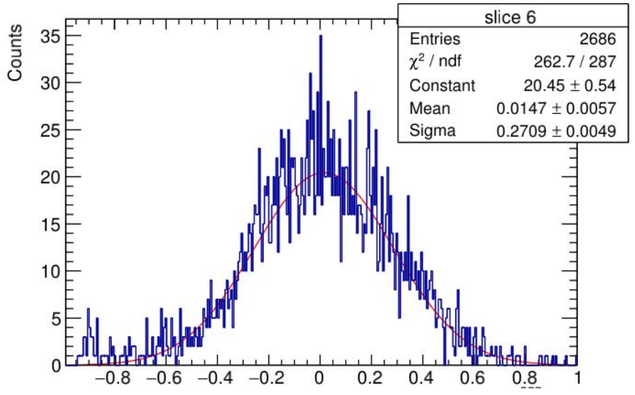


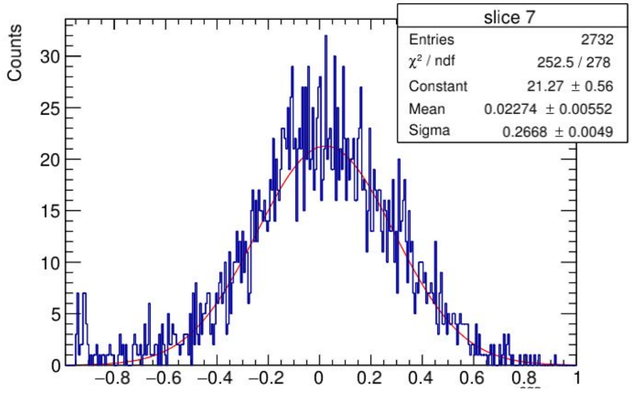


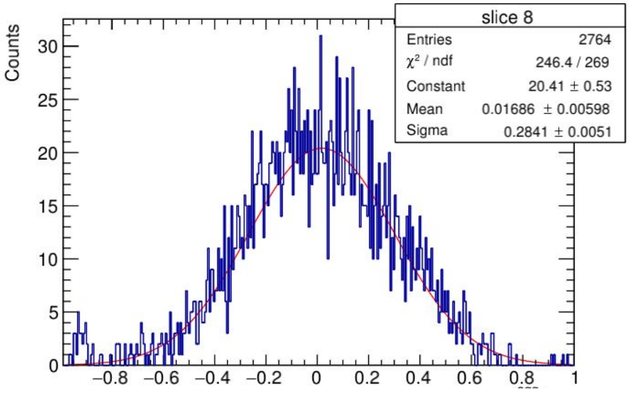


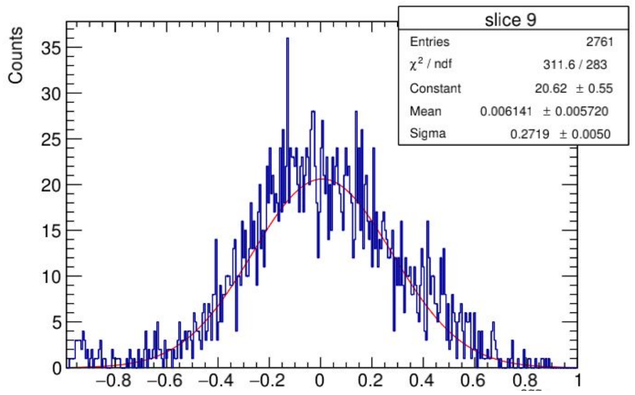


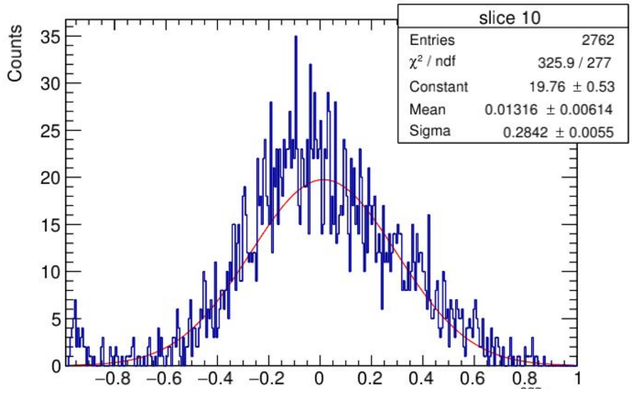












The x-axes denote $\Delta e_{agg}/ge$